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ELECTRIC FANS IN WINTER.

The electric fan is generally associated with hot weather, because at that time we are accustomed to resort to its use for cooling and ventilating our offices and living rooms; but it has its uses in cold weather, and in many offices and stores it maintains its position throughout the entire year. Its use in winter is principally to secure ventilation, though at times it is very convenient for obtaining a more uniform temperature throughout a room. An electric fan placed above a heater will distribute the warm air which would otherwise rise toward the ceiling and only reach the lower regions when displaced by still warmer air. The thorough circulation and stirring-up brought about by the fan generally ensure a pretty uniform temperature throughout the entire room.

Another application of the electric fan in winter is to maintain display windows free from frost. This is done by directing the current of air from the fan across the window, and in this way the increased evaporation which takes place prevents the accumulation of frost. It used to be the case that, during cold snaps, nearly all display windows were completely screened off from persons on the street by a thick coating of frost and ice. This is easily avoided now when one knows the remedy, and there is no need for any store losing the advertising value of its windows, even during the coldest weather.

A USEFUL RAW SCIENTIST.

Sir Oliver Lodge may surely be classed as a scientist of high attainments. He would probably by many of us be placed among those who were recently classified by an engineer—also eminent—as raw scientists—that is, those men who have devoted themselves to science for its own sake, and who seek for no useful application. But now Sir Oliver has stooped, or risen—whichever way one wishes to put it—to turn scientific knowledge to practical uses, and he offers us two applications, each of which, if successful, will be a great boon to humanity.

The first of these is an electrical method of displacing fogs. This was described in the ELECTRICAL REVIEW last spring, and while the method has not yet been put to practical use, it has been tested and gives promise of success. During recent fogs in England this system was tried. The apparatus was fitted up at the laboratory at Birmingham College, and was found quite effective in displacing fogs for some distance around the building. If this can be done on a large scale—such, for instance, as keeping main avenues of traffic open—the adoption of the system seems not improbable; for no matter how costly it itself may be, the losses due to interruption of business are probably much greater. The difficulties of applying this method are many, but England's recent experience may cause it to be tried. It is said that the recent fog cost London five million dollars.

The other invention is one of lesser importance to the public in general, but one very necessary to the happiness of a rapidly growing class—that is to say, the automobilists. It is, in effect, a system of ignition for gas and oil engines which is reliable and will work under all conditions. It is said that one-half of the breakdowns of automobiles are due to failures of the sparking device. Sir Oliver's system, on the other hand, can not be prevented from sparking. Here we have two useful applications which could only be thought of by one deeply versed in science. One perhaps is not so much surprised when it is attempted to apply high-frequency oscillations to transmit messages without wires through space, but it is surprising to see the science of high-frequency electrical vibrations applied to igniting an engine.

LONG-DISTANCE TRANSMISSION.

The interesting paper, entitled "The Maximum Distance to Which Power Can Be Economically Transmitted," read by Mr. Ralph D. Mershon at the recent meeting of the American Institute of Electrical Engineers brought forth a good deal of criticism, though such criticism only adds to the value of the paper, as it puts on record the honest opinions of those most interested in the subject.

We can not agree with the member who took part in the discussion, who held that investigations of this kind were not only a waste of time, but were, in fact, dangerous, as they might be misleading. Any study of this kind can only be based upon certain assumptions, and in this case these assumptions were clearly stated by the author, and, bearing them in mind, the limitations of application of the results are clearly recognized. The conditions of operation assumed in the investigation are such that the results have little bearing on present practice. Transmission engineers to-day are satisfied with 60,000 volts, because they find this pressure sufficiently high to transmit economically the power required over the distances which must be covered to-day. To go above this is merely to invite trouble, without a compensating gain. If, in days to come, much larger powers must be transmitted over much greater distances, it may not only be advisable, but it may be necessary to use higher voltage. There is, of course, the great question, whether there will be any such need in the future. Where a large waterfall exists there should be no difficulty in disposing of all the electrical power which can be generated there within a radius of 100 miles or so. Thus, from the standpoint of the generating company, there would seem to be no necessity of using higher voltages. But there is, of course, the other question: that of transmitting power to a city lying outside this 100-mile radius. However, the demand for power in large quantities, even in large cities, may not be as great as might first appear, because those industries in which the cost of power is an important factor will naturally move to the power plant. This will leave in the city only those industries in which the cost of power is a minor consideration, and which will be willing to pay more for power, since this increase in the cost of operation is more than made up by other advantages of location. There will always be large demands for power in all cities, the individual demands themselves being relatively small, but the aggregate being much greater than might be anticipated. It seems likely that the electrical power required for these purposes will be supplied by a local generating station, placed possibly without the city limits.

It was pointed out that the idea that the development of our waterfalls will rapidly decrease the coal consumption is erroneous. The coal consumed in electric generating stations is only a few per cent of the total quantity used. This percentage will increase as years go by, but it will be some time before the electric generating station is a considerable factor in the use of coal.

As a caution to those who look upon Mr. Mershon's paper as a prophecy of what the future has in store for us, the dreadful example of certain earlier prophets in electrical developments was held up. But if these earlier prophets had stated, as does Mr. Mershon, the conditions upon which their forecasts were based, there would have been no need to apologize when their prophecies failed of fulfilment, due to a change in these conditions. A prophet need not give his reasons when he prophesies. Indeed he would probably lose caste if he did. But an engineer, when forecasting the future, should always state clearly upon what his reasoning is based; and as long as his reasoning is sound, his reputation will suffer nothing if improvements in methods or apparatus set his forecast at naught. What the future has in store for us in the direction of long-distance transmission of electrical energy no one can say with any certainty.

A SERIOUS OFFENCE.

Certain telephone lines in eastern Massachusetts have suffered severely of late from the depredations of copper thieves, and thus far attempts to apprehend the culprits appear to have met with but little success. There would be slight occasion to trespass upon a field which so palpably lies within the province of the police department, were it not for the fact that the serious character of this old offence is not always sufficiently appreciated in even highly developed communities.

Leaving aside for the moment the question of detection, it is worth while to examine the grave nature of this species of larceny, for in many cases it seems to be regarded by the general public as little more than petty thieving. To be sure, twenty-five dollars worth of copper is not a bad night's work from the standpoint of the wire cutter, but this is not the point which makes the offence so serious. Unfortunately the wire thief does not confine himself to breaking into storehouses and abstracting stray coils that lie handy to his purpose—a course which entails far less momentous consequences in its possibilities than the deliberate cutting and stealing of operating circuits which may be carrying signals or messages of the gravest import. It requires no very active imagination to picture the financial losses incidental to the severing of wires occupied by business conversations of moment; the ruin which the cutting of a fire-alarm circuit during the striking of a box may scatter abroad; the calamities hinging upon the continuous transmission of train orders, and the personal anguish and bereavement capable of being caused by the interruption of a physician's telephone line at some time of physical crisis, when life and death are fighting a battle of seconds.

Short shrift used to be accorded the horse thief in the old frontier days, for in those times the loss of a horse often was tantamount to death by starvation or thirst. Vital as the telephone has come to be—and the telegraph as well—in modern civilized life, the consequences which may hang upon its interruption are oftener far from realized. The crime of stealing wire from operative lines certainly deserves a penalty heavy enough to deter the wire cutter from what he regards at present as an easy way and a comparatively harmless way of making a little money.

SERIOUS BREAKDOWN OF AN ENGLISH LIGHTING PLANT.

Just about a year ago the electrical supply of the city of Bristol, England, was entirely interrupted by a disastrous fire which destroyed the switchboard in the lighting plant. Happening at Christmas time the interruption was the more serious, as it interfered seriously with the holiday shopping.

This year another breakdown has occurred, just before the holiday season, this time at the Bradford municipal plant. On the morning of December 13 a serious short-circuit occurred in one of the underground mains of the municipal lighting system. The fault was located in a feeder laid across an iron bridge over a railway. This feeder was disconnected, but a heavy fault still remained. Upon opening the pavement it was found that the arcing had burned a hole in the iron plates forming the bottom of the bridge. The cable, upon test, was found to be faulty in both directions. A little later in the morning another fault occurred a short distance from the first. In this case an explosion of gas took place. Upon opening the conduit, which consists of two brick and stone culverts, it was found that nearly all of the fifteen cables had been burned in two. Explosions continued even after the feeders had been disconnected. The entire plant was shut down while repairs were being made, and connection was not made again until about midnight. In the meantime another breakdown occurred in an entirely different part of the system. By energetic work this fault also was located and repaired, and early the next morning the system was working normally.

It was found, on making tests, that the cables affected were in bad condition. They had been laid between eight and sixteen years ago. They were lead-sheathed, single-core cables, and the type of joint-box used was poor. The trouble seems to have been due to general deterioration. In fact, the engineer had reported to the municipal lighting committee that the system was in bad condition and needed immediate attention.

This unfortunate occurrence emphasizes the necessity for watching and testing carefully all electrical conductors. One is apt to feel that when a system is working apparently satisfactorily—as no trouble is seen on the surface—that all is well. Where conductors are strung overhead trouble is expected and precautions taken, but when they are laid underground, a feeling of security tends to diminish the sense of responsibility for their maintenance in good condition. In this case deterioration must have been going on for years, and this should have been evident on making tests. Part of the cause of the Bradford trouble seems to have been due to the neglect of the former engineers to keep careful records of the system, for not only had these defects not been corrected, but when the breakdown occurred and repairs were being made, cables were found lying beneath the conduit which those in charge at present did not know existed, and these cables were found to be connected up improperly to the mains. The lesson is evident: it will not do to treat electrical conductors as permanent equipment not liable to deterioration, and no matter how well constructed and how carefully laid, they must be inspected regularly and any tendency to trouble noted and checked at once. Only in this way can a disastrous failure of a system be avoided.

THE INDEX FOR VOLUME FORTY-FIVE.

With this issue the forty-fifth volume of the ELECTRICAL REVIEW is completed. Accompanying each copy of this number will be found an index for the twenty-seven issues, covering the period from July 2 to December 31 inclusive. No additional copies of this index will be distributed, and we urge upon all recipients the importance of preserving this record. The greatly enlarged scope of this journal is evident from a glimpse at this index, and it is gratifying to realize that this effort is being so warmly appreciated throughout the field. The year just closing has been crucial in many respects. For a time it looked as though the pendulum of business activity might swing too far off-side, but the trend of progress now indicates an era of prosperity and national happiness which shall be as great as, if not greater than, any which has been passed through. In bringing this forty-fifth volume to a close we wish our good friends throughout the world

A PROSPEROUS AND HAPPY
NEW YEAR.

SUBWAY WEATHER.

The sample of winter with which New York city has been visited during the past fortnight has emphasized the advantages of the subway as a means of travel. Above ground traffic has been impeded everywhere by the heavy falls of snow and slush, and getting about the city on the surface has been difficult, as well as disagreeable. In the subway all is different. Here, except for the dripping umbrellas and snow carried in by the passengers' feet, there is nothing to indicate that above ground the sun is not shining and the streets bright and pleasant. There is no delay due to stalled teams or sleet, or to allow a snow sweeper to clear the way. Except for the walk to and from the subway, those who travel in this way are independent of the weather. The subway had shown its usefulness before bad weather set in, but the storms of the past two weeks have brought out more forcibly than ever the advantages of traveling underground. The city is not only satisfied with its subway, but it means to have more of them, and it is not improbable that one or more, and possibly all, of the elevated lines will eventually be replaced by new subways. The gain to the city would be great.

As the subway service settles down to smooth running, changes which might be made with advantage are pointed out. Criticisms are most frequently heard of the arrangements for leaving and entering the cars. Here the greatest loss of time occurs. A modified type of car with side doors such as that used on the Brooklyn bridge, or, even better, the type of suburban car adopted by the Illinois Central Railroad, would improve present conditions considerably. A change of some kind will doubtless be made in time.

GROUNDED TRANSMISSION MEDIUMS—VI.

BY J. STANLEY RICHMOND.

TRACKS AND BONDING.

In spite of all that has been written and said, and though the average traction engineer is well aware that it is important that the track conditions, from a conductivity point of view, should be kept up to the standard required by modern and approved engineering, it is remarkable how many railroads permit their bonding to deteriorate. This is very regrettable, and can only be explained on the basis that such being hidden from officials, it is not constantly brought to their notice like the conditions of the other phases of street railroading are. Bond testing should be methodically carried out constantly; that is, as soon as the whole system has been tested, it should be all gone over again and again to the N times. For this purpose a Conant rail-joint testing instrument with the built-up frame contacts (not the poles) should be used. The operator should be a young man of a plodding—very plodding—character and his assistant, a boy. Both of them should be on the pay-rolls of the maintenance of way department. The young man should receive two dollars, and the boy fifty cents a day. Both of them should report at the office at 8.30 A. M., be at work on the streets at 9 A. M., go to lunch at noon, be back at work on the streets again at 1 P. M., start for the office at 4.30 P. M., and on arrival there enter up the readings on clean sheets, a fac-simile of which is given in Fig. 24, and leave them, before quitting at 5.30 P. M., on the desk of the head of the department. The head, on the first of each month, should turn in the accumulated sheets, with a brief attached criticism of them, to the general manager for perusal. To check the accuracy of the Conant rail-testing instrument, a duplex millivoltmeter (Richmond pattern) is very handy. Such an instrument has been mentioned in a previous article ("Stray Transmission")[1] in connection with the first method of testing for stray transmission, and is used by taking the track drop across the joint with one side of the instrument and the drop across three feet of straight rail with the other side of the instrument. Ordinary good bonding carried out with one bond at each joint in outlying sections and two bonds at each joint where the loads accumulate, with, perhaps, three bonds at each joint in some special cases (where the load is exceptionally heavy), will give results showing, in many cases, joints and straight rail as equal; that is, the conductivity of three feet of joint (eighteen inches each side of the junction of two rails) is the same as that of three feet of straight rail (rail without any joint); in other cases the results will show that the joints are equal to six or nine feet of rail. Where the bonding is out of order, the results, of course, will show much worse conditions. Where the tests give joints as being equal to more than six feet of straight rail, the joints should be rebonded. The practice of drilling holes in the rails beforehand, to insert the bond terminals in, can not be too strongly condemned, unless they are drilled slightly smaller than required and are reamed out to the right size just before the bonds are installed. This because the holes will accumulate a certain amount of moisture and oxide in a very short time, which will, sooner or later, cause imperfect contact between the bond terminals and the rail metal. Bonds should be flexible and preferably of the ribbon type. The bond terminals should be large—very large—and welded by some heat process to the ribbons (not pressed), and when inserted in the rails should be swaged up by compression applied to the head and the other end. When soldering can be carried out, the terminals and the rails should be sweated first; and when the terminals have been compressed heat should be applied to make the two sweated surfaces run together. The terminals should then be compressed again.

Those who are practically acquainted with track conditions, considered from the point of view of conductivity, know, more or less, that it is very difficult to keep the bonding of special work, as it is usually carried out, up to standard. This is due to several reasons; the three main ones being the more than usual amount of motion at the joints which loosens and breaks the bonds; the use of small lengths of rail to "make-up"; and the extra trouble which is experienced in getting at the bonds for repairs, especially when the special work is the result of cross lines with the thereby heavy traffic. Carefully taken short track-drop readings generally show, when the bonding on clear runs is in fairly good condition, that most of the total drop is due to the drops across the pieces of special work (steam railroad crossings being the worst offenders) unless the ordinary special bonding is new, when the drops across special work will be less than that across equal lengths of clear track. This has been somewhat generally understood for several years; and, as a result, it has been customary to lace the special work with lengths of bare wire, usually trolley wire, though in some cases galvanized wire has been used. The writer, therefore, adopted for such points a class of bonding which he terms special bonding, the details of which will be given further on.

When new track is being laid, the special work and the ends of the clear runs should be connected together without the use of short lengths of rail to make-up; that is, if fifty-foot rails are being used and the distance to be connected up is sixty feet, one fifty-foot length and a ten-foot length should not be used. What should be done in such a case is to cut two thirty-foot lengths off two fifty-foot rails and use them to make-up the sixty-foot space. Short lengths, therefore, when used, should always be used on the

BANK AND BUNK RAILWAY COMPANY,
Bank, Bu.

BOND TEST SHEETS.

..... Test. Sheet No. .....

Tests made by.....

Date .....

Weather.....

Preceding weather ..... for ..... days.

Locality.	Joint No.	North Track.		South Track.		West Track.		East Track.	
		N. Rail.	S. Rail.	N. Rail.	S. Rail.	W. Rail.	E. Rail.	W. Rail.	E. Rail.

FIG. 24.—REPORT SHEET.

[1] ELECTRICAL REVIEW, December 17.

clear runs. The special work should be extra ballasted, and the extra ballasting should be continued on under the clear runs (gradually tapering) for a short distance. It is also a good plan to use, for the top of such ballasting, a dressing of concrete. This concrete should be rammed in after the special work and clear runs

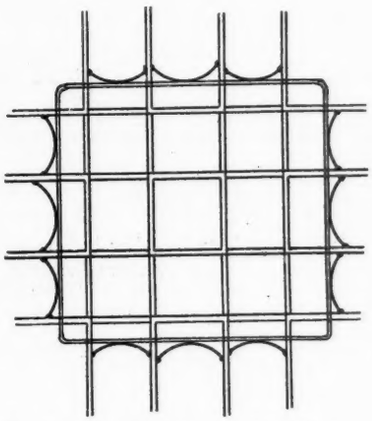


FIG. 25.—OLD METHOD OF RAIL LACING.

have been bolted up; and, if possible, no cars should be run over it until the concrete has set. If this work is being done on a road which is only operated during the day, the concrete should be rammed in as soon as the last car has passed, which will give it a few hours to so set. This policy will reduce the joint-motion at such points to a minimum; and it is absolutely necessary that the special work should be carried out in a very substantial manner when it is the result of a steam-railroad crossing.

In track maintenance it is often found that the joints at certain points of the clear runs show considerable motion. At the points where repairs are found to be constantly required (evidence of which will be shown by the repeated bond tests), it will generally be found, on examination, that the trouble is due to the unstable character of the foundation soil as a result of surface or other drainage. The cure for this is to dig out the under-soil for about two and one-half ties each way, place a longitudinal tie under and attach it to the four tie ends and then fill in with stone ballast, which should be well rammed. If the motion is due to rotting sleepers (ties) as a result of soggy ground, the ties should be replaced with creosoted ones, creosoted by the vacuum process (not the superficial one); and if the conditions producing rot are extreme (alternating sogginess and dryness) the ends of the ties should, before installation, be dipped into a tank of P. & B. paint, thinned down with carbon bisulphide, a commercial quality of which can be bought by the carboy. The use of iron ties is not recommended.

It is much preferable, however, to use, instead of the concrete, box troughs with a minimum cross-sectional area, into which, after the top has been nearly all nailed down, melted pitch, mixed with a little tar to keep it moderately soft, is poured.

Fig. 25 illustrates the old-fashioned method of rail-lacing, while Fig. 26 represents how similar special work is provided with special bonding.

Fig. 27, in a similar way, shows how a turnout was originally strengthened. Such a plan has, however, been proved to be exceptionally weak; and the method which should be adopted is illustrated in Fig. 28.

Where the turnout is more complicated on account of it forming the junction between two lines, the special bonding becomes more complicated. Fig. 29 shows the old lacing method; while Fig. 30

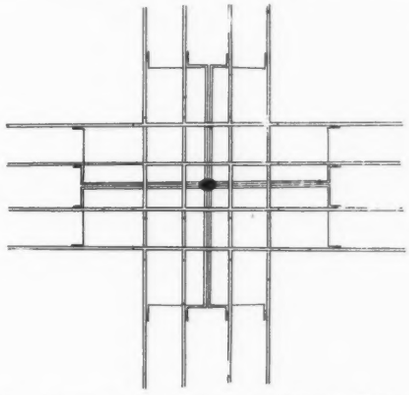


FIG. 26.—SPECIAL BONDING ON SPECIAL WORK.

illustrates the modern and approved plan; in which case, as will be noticed, part of the special bonding is laid to one side of the tracks. This is because it is often very difficult, when installing this work in connection with track which has been previously laid, to dig a trough near the tracks on account of the many ties. There are so many forms of special work that it is beyond the limit of an article to give all the combinations which can be worked out; but it is believed that the few examples given will assist the track engineer to understand the principle involved.

A few of the details to be observed in connection with this work are as follows:

The cable should be double-braided weatherproof with a stranded core made up of tinned wires. This on account of the considerable amount of soldering which is necessary. The size of the cables should, according to the loads at the different points, run from 200,000 to 1,000,000 circular mils.

The terminals which are used to connect the cables to the rails are illustrated in Fig. 31, the ribbons of which should be spread out and coiled around the ends of the cables (previously cleaned with gasoline) and then soldered by pouring melted solder over the junctions of the two.

The number of rail connections at each point should vary from three to six, according to the loads to be taken care of.

All the cables at each piece of work should be bared about the middle, then cleansed, bound together and finally be sweated and covered with tape and painted with P. & B. paint.

A slight kink should be made in each cable end near to the rail contacts; and, when the contacts are made, they should receive a liberal covering of the insulating paint.

To carry out this work, the first requirement is that accurate tracings to scale should be made of each piece of special work. Blue-prints from these should be then sent to the electrical engineer who should mark on them the sizes of the cables to be used and the price of such per foot. They should then be handed over to the track engineer. This is the man who by a little originality and patience can save a few hundred dollars. A couple of hours spent on the blue-print of each piece of work will be found to be a paying investment. As the track engineer finishes each sketch of the points to which the cable ends are to be connected and the route for the cables to follow, it is returned to the drawing office pinned to the blue-print with any notes which may be found necessary. The drawing office should then complete the tracings and, when it is finished, send a blue-print from it to the electrical

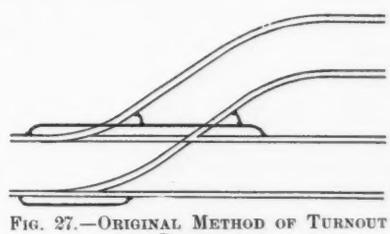


FIG. 27.—ORIGINAL METHOD OF TURNOUT BONDING.

engineer, so that he may check the sizes of the cable given. When so checked, he should forward it to the track engineer, by whom it is handed to the foreman on the job. Any deviations from the blue-prints which the foreman may find necessary should be mentioned in his daily reports to the track engineer,

by whom the drawing office should be notified, so that they may make the necessary changes on tracings.

It is advisable that this work should be simultaneously installed at several points; in which case the track engineer will probably find it necessary to have an assistant to deal with instead of his regular foreman. This assistant should be a bright, active and intelligent young engineer with two quick eyes in his head and a fine quality of gray matter behind them; in fact, an embryo expert. His remuneration should be at least $90 a month.

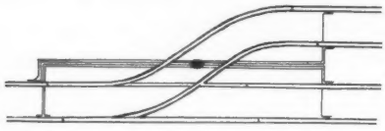


FIG. 28.—IMPROVED METHOD OF TURNOUT BONDING.

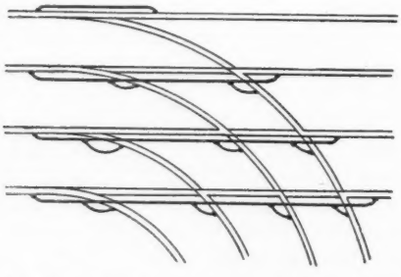


FIG. 29.—ORIGINAL METHOD OF BONDING AT JUNCTION.

Particularly must he keep his eyes on every part of the work undertaken by the bonding men. The number of men in each gang on the special bonding will vary, according to the area covered by the special work, from six to twelve; and they should be strong and active street laborers at the highest local rate of pay. Each gang should have a boss. College technical students who are husky football players make good bosses; remuneration, $50 a month; hours, 7 A. M. to 6. P. M. Some leniency should be allowed toward the men on hot days, especially during the middle hours; and plenty of iced water, with a liberal allowance of oatmeal in it, should be provided.

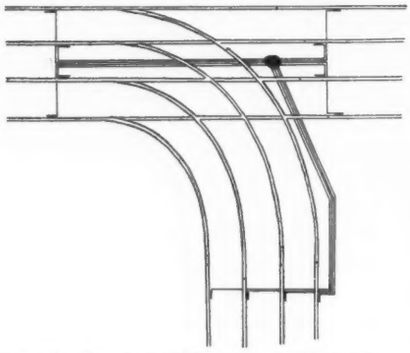


FIG. 30.—IMPROVED METHOD OF BONDING AT JUNCTION.

As for auxiliary insulated copper (return feeders), they in the majority of cases, will be found to be only nccessary where the tracks converge near the powerhouse; provided that the ordinary and special bonding has been carried out as has been already outlined. The cables, for this purpose, should be insulated right up to the connecting points, each of which points should be the junction of the middle points of the cables used for the special bonding of a piece of special work. Such connections, after they have been well soldered, should be plentifully taped and thoroughly painted with insulating paint. To attempt to give, even roughly, an idea of the one, two, three, four or more points that such auxiliary copper should be run to, would be absurd. For the location and number of such points are governed entirely by the lay-out of the tracks and the special conditions pertaining thereto. Such work, of course, should come under the charge of the electrical engineer and be carried out either by his line or conduit department.

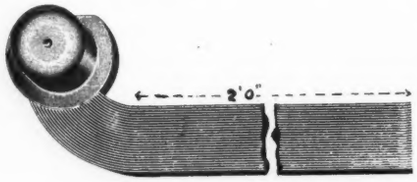


FIG. 31.—CABLE TERMINAL.

Engineering Department of the University of Texas.

An engineering department has been organized at the University of Texas. There is an increasing demand for technically trained men in that state, and the university is making every endeavor to supply thoroughly trained and competent men.

The undeveloped resources of Texas offer many opportunities for profitable investment. This is particularly true of certain mineral products of Texas and of the undeveloped water powers; and the climate is most suitable for long-distance transmission of electric power.

The following courses have been organized in the engineering department: civil engineering, electrical engineering, mining engineering and sanitary engineering. Mr. Thomas Ulvan Taylor is head of the department of sanitary and civil engineering; Dr. Arthur Curtis Scott is head of the department of electrical engineering, and Dr. William Battle Phillips, of mining engineering.

A new building for the use of this department is now in course of erection. The building is 125 feet by sixty-five feet and is four stories high, of Austin yellow pressed brick with limestone trimmings. The structure is of brick, steel and cement concrete, making it entirely fireproof. It is lighted with Nernst lamps. The dynamo laboratory is on the first floor, and is a room sixty feet by thirty feet. All wiring is carried in a brick tunnel five feet wide and seven feet high. Adjoining the dynamo room is a storage-battery room. The laboratory will be provided with a traveling crane for moving the machinery.

The electrical engineering lecture room is on the first floor, just above the dynamo laboratory. It is fitted with a strong table and an elevator, enabling electrical machinery to be brought up to the lecture room from the laboratory. Adjoining the lecture room there is an apparatus room, also a small electrical laboratory and the office of the head of the department. There is a third small electrical laboratory on the second floor.

The third floor of the building is given up to draughting rooms, photographic laboratories, etc.

Electric Operation of Mills in Spain.

The *Electrical Engineer* (London) reports that electrical operation is to be adopted in two spinning and weaving mills at Malaga. These are the largest mills in Spain, and employ about 5,000 hands. The mills are owned by the Marquis of Larios, and he has arranged to obtain a supply of power from the Chorro Power Company, which has erected a station in the celebrated Chorro Gulch, fifty miles north of Malaga. Power is transmitted from this station in three-phase currents at a pressure of 25,000 volts, to a substation in Malaga, where the pressure will be reduced to 2,500. At the mills it will be reduced to 400 volts for supplying three-phase motors, which will be used throughout the mills. The present steam plant will be discarded. There will be seventy-two of these motors, varying from 3 to 150 horse-power, and aggregating 2,500 horse-power. It is estimated that the use of the electric motors will effect a saving of over twenty per cent in operating costs.

The Telephone in Paris.

It is reported in the European press that the telephone service in Paris has become so bad that a mass meeting of subscribers has been held, in order to make a formal protest and to demand an increase in the efficiency.

The New Jungfrau Locomotives.

By C. L. Durand.

THE new three-phase electric locomotives which are now used on the Jungfrau (Switzerland) electric road are worthy of a special description, as they embody all the most recent ideas. Two different types have now been constructed and are working successfully.

The electric equipment of the No. 1 and No. 2 type of locomotive, shown in Fig. 1, has been designed by the Swiss firm, Brown, Boveri & Company, of Baden, while the mechanical part is executed by the Swiss Locomotive Company, of Winterthür. The entire locomotive rests by means of a set of springs upon two main carrying axles which are designed so as to work independently of the motor-driven axles of the locomotive. The latter axles with their gearing turn in bearings which are fixed rigidly upon the truck body. When in the usual conditions of running, the locomotive is combined with a passenger car. The latter is of special design, and it is to be noted that the side-bars of the car project out in front and rest upon the locomotive itself. It is attached to the locomotive truck by a form of universal joint coupling, which gives it a freedom of movement. In practice the locomotive can be used either alone or to draw a train of cars.

Three braking systems, each of which is capable of controlling the entire train, give a good security, which is in fact an essential point on an incline road. The gearing is prevented from jumping out of the road rack by a special grip device which keeps it in place. Two of the sets of brakes consist of ordinarily brake-shoes which are operated by hand and act directly upon the pulleys at the right and left of the two gear-wheels which engage with the rack. The third braking device is operated by centrifugal force and it acts simultaneously on the band brakes of the motor shaft and on the switch which breaks the current to the motors. This device comes into play when for any cause the speed of the locomotive exceeds a certain fixed rate. Besides working automatically, this brake device can be also worked by hand either on the locomotive or from the car platform. The safety grip which has been above mentioned is suspended from the axle by a universal joint and has a pair of jaws which embrace the flange of the rack-rail. It can be regulated to the proper point. In case it is necessary to make a long coast in going down grade without using current on the motors and only with the aid of the hand-brakes, the locomotive has been furnished with a special device for cooling the brakes so as to prevent their overheating on the long descent. This is a great advantage in practice.

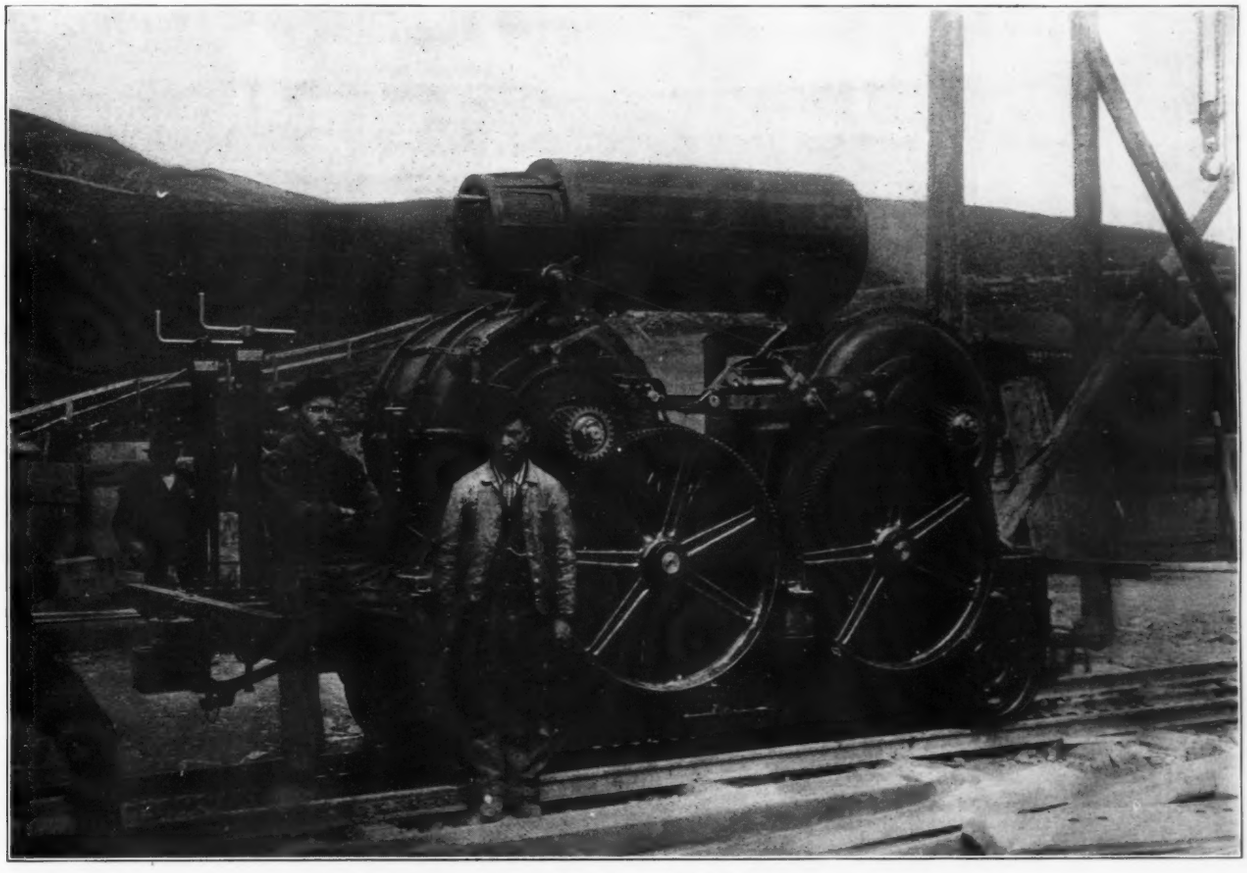


FIG. 1.—NEW JUNGFRAU, SWITZERLAND, ELECTRIC LOCOMOTIVES, TYPES NO. 1 AND NO. 2.

Each of the locomotives has a total

weight of about fourteen tons and is equipped with two non-synchronous motors using three-phase current. Each of the motors is designed to develop 150 horse-power on an average running. The working voltage on the motors is 500, and they make 760 revolutions per minute, at a frequency of thirty-eight cycles.

The two motors of the locomotive are quite independent of each other, and each of them has a set of reduction gearing which connects them with the main pinions of the road-rack. There are two of the latter pinions. The total speed reduction from motors to pinions is 11.5 to 1. It is carried out by two successive gear sets, the first of these having a ratio of 5.25 to 1, while the second set has the ratio 2.22 to 1. The rack pinion works at the rate of sixty-five revolutions per minute. It measures 700 millimetres in diameter. The total pressure of the gear-wheels on the rack is estimated at nearly nine tons. The locomotive is designed to run at a constant speed of 8.1 kilometres (five miles) an hour, both in the mounting and the descent of the track. As will be observed in the engraving, the starting resistances for the motors are placed in a large and well ventilated iron case at the top of the locomotive, and are held to the motors by a set of cast-iron brackets. The current-changing switch for reversing the motors is placed under the roof of the locomotive. The latter has been removed in the present case. Current is received by the motors from a set of four trolley poles of special form. Two poles per phase are employed. The third phase is represented by the rails. Each of the locomotives is furnished with an ammeter, a lightning arrester, four automatic circuit-breakers and a speed indicator. Fig. 2 shows the scheme of connections of locomotives 1 and 2.

When the connections of the motors are disposed for the descent of the train (the rotors being then put on short-circuit) the motors begin to work as generators as soon as they reach the speed which corresponds to synchronism. The energy which is developed by the descent of the train is then transformed to electric energy. In this case the motors act as brakes, and the maximum speed which they can reach is that of synchronism, increased by a very small value which corresponds to the slip. The current which is thus produced returns to the central station by the conductors. In the case where several trains are engaged in the descent at the same time, it might happen that the central station machines receive a greater amount of current than they generate. This might cause the dynamos and turbines to race and take a dangerous speed. In order to avoid such a condition the central station is provided with a set of resistance coils which can absorb the surplus of current and keep the machine at the normal speed.

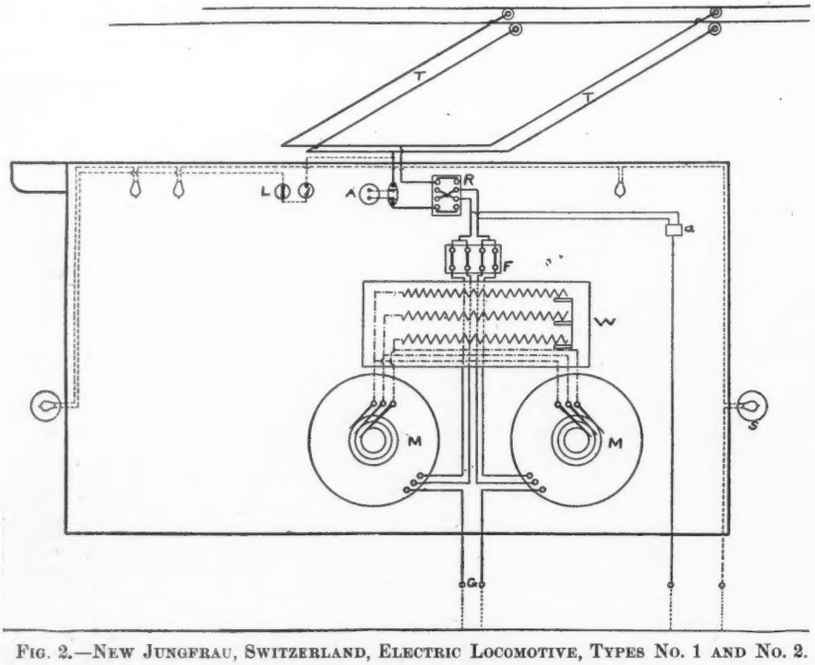


FIG. 2.—NEW JUNGFRAU, SWITZERLAND, ELECTRIC LOCOMOTIVE, TYPES NO. 1 AND NO. 2.
M—Motors; W—Resistance; F—Fuses; R—Reversing Switch; L—Lamp Switch and Fuse; A—Ammeter; T—Trolley; G—Rack Contacts; *a*—Lightning Arrester; *s*—Signal Lamp.

The new locomotive No. 6, shown in Fig. 3, presents some interesting innovations in its design. As regards the construction of the electrical part, it has considerable differences from the former locomotive of the Jungfrau railroad. In designing the new type the constructors paid special attention to the fact that in the present condition of working, before it is used to draw the passenger cars, it will first be employed in transporting the material coming from the excavation of the tunnel while the latter is being finished. Allowing the trains of the hauling cars to be of ten tons weight, on an average, in excess of the usual passenger trains, this made it necessary to give a special design to some of the parts of the locomotive. These portions had to be made much more resistant than those of the former type of locomotive, seeing that the pressure of the pinions on the rack is now greater than twelve tons. The new type closely resembles the old as to exterior profile, the distance between the main carrying axles and the mechanical equipment, and the passenger cars are attached to it in the same way. In the present type the weight has been increased to 18.5 tons. It is provided with two three-phase motors, each of which can develop an average of 150 horse-power. The motors make 760 revolutions per minute and operate with a voltage of 450 to 600 and thirty-eight cycles. When going up grade the locomotive has a constant speed of 8.1 kilometres (five miles) an hour. In the descent, the same speed is maintained as long as the motors remain in connection with the supply circuit. But when on the down grade it is possible to run the locomotive quite independent of the overhead line and the machines in the station. A special arrangement allows of regulating the speed as desired, between a maximum of five miles an hour and a minimum which is only five per cent of the maximum speed. The former locomotives which were built for the Jungfrau railroad had the same facility of remaining independent of the generating current in the descent of the track, but they had not the same advantage in obtaining such a wide variation of speed as now. In fact, the maximum speed variation was made between the normal number of revolutions per minute and one-half this number. This was obtained in the former case by making the non-synchronous motors work as generators, and the current which they furnished was absorbed by a set of resistance coils disposed to this effect. The exciting current is here furnished by a small machine which is mounted independently on the motor shaft, and this current can be regulated by a rheostat.

In the new locomotive a different system has been adopted which gives better re-

sults as to the limits of varying the speed. The special construction of the motors allows them to be connected so as to work as non-synchronous motors, and as generators when on the descent. To this end the rotor of the new motor is provided, on one side, with a set of three collecting rings and brushes, for inserting the starting resistances in the circuit. On the other side it carries a collector of the usual kind. When the motors are connected with the overhead line so as to take the main current, a three-phase magnet device is operated so as to lift the brushes off the collector by means of a series of levers adapted for the purpose. During the descent, the starting resistance can also be made to serve as an absorbing resistance for the current which the motors give when working as generators. For this purpose these resistances are designed so as to absorb about 170 kilowatts for a considerable time without undue overheating. However, as this gives rise to a certain quantity of heat the coils are cooled by means of an air-fan which is driven by a small three-phase motor mounted on the locomotive. Fig. 4 shows the scheme of connections.

The locomotive is operated by a controller (Fig. 5) which will be noticed on the front platform. It contains a reversing switch for changing the direction, also the controlling device for the starting resistance and the brake resistance. The controller for the former is in the shape of a four-point switch; two points are used for reversing the car while the motors are connected with the overhead line, one point applies the electric brakes when the former connection is broken, while the fourth point corresponds to the stop position. In this last position the operating handle can be taken off the controller. In practical operation they use the forward movement of the car for the up grade, and the rear movement ,and the brakes in the descent. In the position of forward and rear movement the motors are connected to the trolley wire and the speed of the train is about five miles an hour in both cases. In the braking position, the connection with the line is cut and the controller places the circuits of the motor so that it works as a generator, as seen above, and the resistances are then constantly in circuit with the rotors. As the generators are operated by the descent of the locomotive they develop a certain amount of power which the resistances absorb, and this can be regulated at will. Consequently we obtain an efficient braking and speed-regulation.

To avoid a false manœuvre, the operation of the small lever of the revolving four-point switch above mentioned is combined with that of the main hand which controls the resistances, so that the two will work together properly, and the switch lever can not be displaced in the following cases: (1) with the motors running on the line, in case the resistances are in circuit with the rotors; (2) with the motors disconnected from the line, where their armatures are not as yet put in

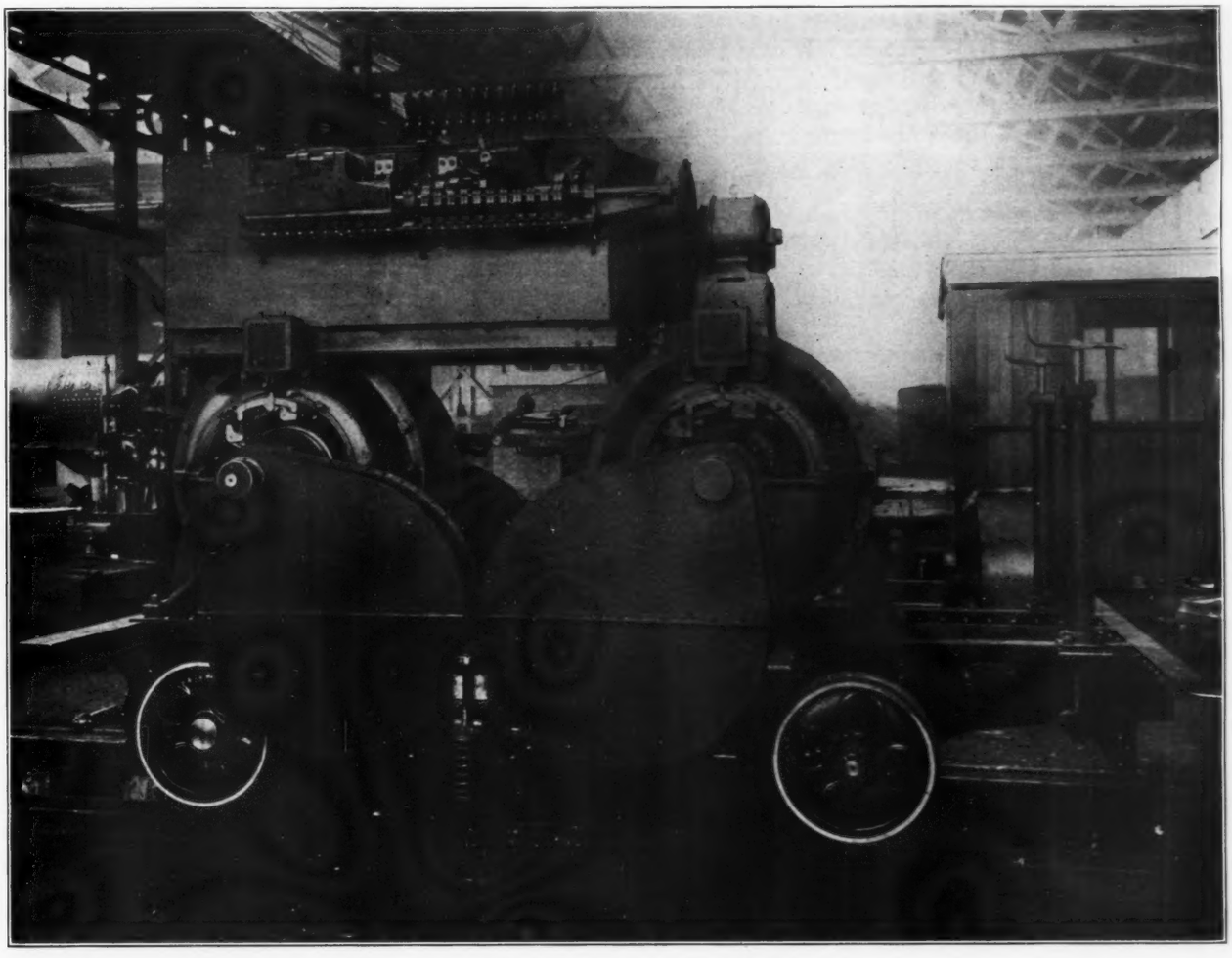


FIG. 3.—NEW JUNGFRAU, SWITZERLAND, ELECTRIC LOCOMOTIVE, TYPE NO. 6.

short-circuit. To prevent the motorman from causing an abrupt change of speed, through negligence, while the locomotive is descending by means of the braking resistances, a stop electromagnet which is placed within the controller is caused to act upon the main steering wheel as soon as the current passes a certain limit caused by a too sudden lowering of the resistance. This disposition is designed to avoid the shocks which in the long run might become dangerous for the mechanism of the locomotive as well as for the rack. The new locomotive is provided like the old with an automatic brake which comes into action as soon as the locomotive reaches an excess of speed equal to ten kilometres (six miles) an hour. This is a centrifugal device which acts upon the band brakes placed upon the motor axles and at the same time operates a safety switch for cutting the motors off the line.

When the automatic brake comes into play, the hand-wheel of the controller remains in the position which it formerly occupied, in case the motorman neglects to bring it to the stop position. In this condition it might happen that the locomotive be set in movement without having the resistances all in circuit. To avoid this, a mechanical device prevents the closing of the safety switch before the main wheel of the controller is brought to its initial position. Two hand brakes are now used, one of these works upon the friction wheel of the previously mentioned brake, while the second works on a pulley mounted on the shaft of the rack pinion. The system of jaws used on the former type of locomotive for keeping the pinion against the rack is retained here.

The rest of the outfit includes a voltmeter, lightning arrester, a special switch, two main circuit-breakers, two ammeters, a transformer for the lamps and a speed indicator which is run from the rear motor. In the present case the disposition of the different working parts was made the object of special study, and the designers succeeded in using a single controller placed on the front of the locomotive to contain the manœuvre of all the apparatus, including the electric braking resistances, and in this way the locomotive can be operated as easily as an ordinary tramway car.

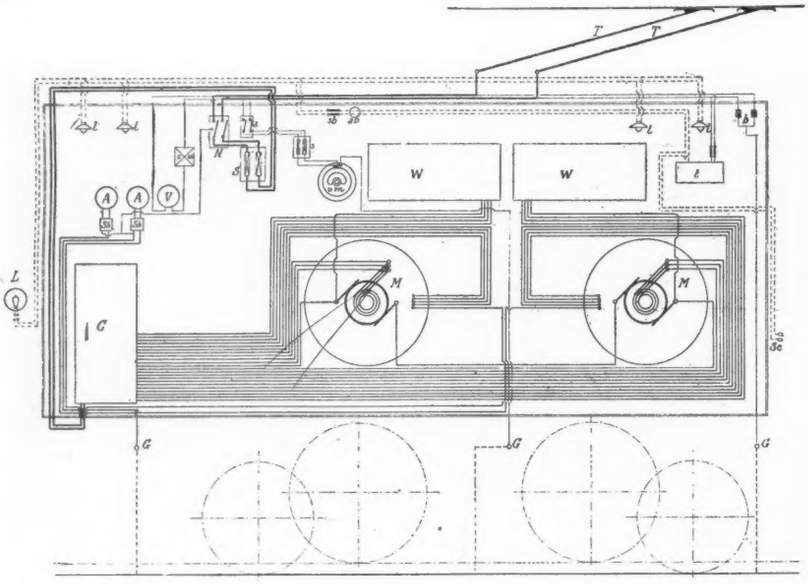


FIG. 4.—NEW JUNGFRAU, SWITZERLAND, ELECTRIC LOCOMOTIVE, TYPE NO. 6.

M—Motor; G—Main Controller and Reversing Switch; W—Starting and Braking Resistance: Rotor Cutout Switch; S—Main Fuses; T—Trolley; *vm*—Ventilator Motor; *s*—Ventilator Motor Fans; *a*—Ventilator Motor Switch; *t*—Lighting Transformer; *l*—Car Lamps; *ab sb*—Lighting Circuit Switch and Fuses; *l*—Signal Lamp; *a*—Ammeter; *v*—Voltmeter.

Street Telephones in Cleveland.

The Cuyahoga Telephone Company, of Cleveland, Ohio, has established two street telephones on lamp posts on Euclid avenue. There is only one other city in the United States which has street telephones, namely, Bridgeport, Ct. The telephones are in boxes to protect the instrument from the weather, but they are accessible to the public at all times. The company expects ultimately to install street telephones throughout the city. The public is permitted the free use of these telephones until January 1. After January 1, except for ambulance, fire or police calls, they will be regular pay stations.

CONDENSERS FOR STEAM TURBINES.[1]

BY GEORGE I. ROCKWOOD.

Visitors to steam turbine power stations generally notice, as a first impression, the relative inconspicuousness of the turbine itself in the midst of its numerous and large condenser auxiliaries. This prominence of the condenser equipment is especially noticeable in the case of the smaller turbine plants, where the floor space occupied by the condenser system far exceeds that required by the turbine.

There appear to be three accepted designs for these condenser systems: first may be mentioned the combination consisting of a surface condenser, a centrifugal hot-well pump, an air cooler, a single-cylinder dry-vacuum pump, a centrifugal circulating-water pump, together with their connecting and drip piping and valves. Second, the foregoing arrangement may be varied by omitting the hot-well pump and also the air cooler and dry-vacuum pump, substituting the wet-vacuum pump—preferably of the Edwards type. The cost per kilowatt is about the same—$7 to $10—for either of these systems. The third system is like the first, except that an elevated jet condenser with barometric tube and hot-well take the place of the surface condenser

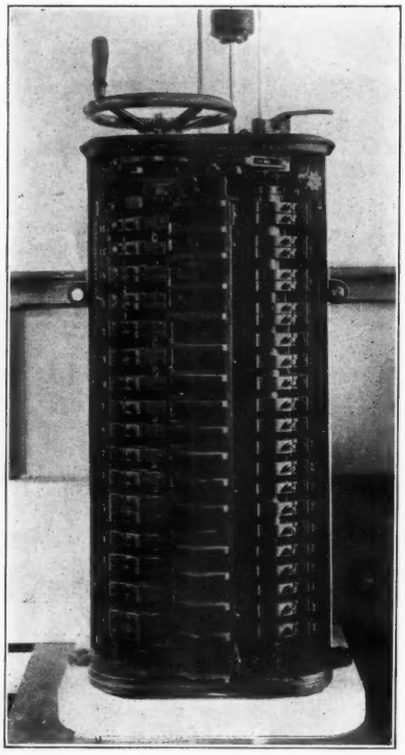


FIG. 5.—NEW FORM OF CONTROLLER FOR JUNGFRAU LOCOMOTIVES.

[1] Abstract of paper presented at the New York meeting, December, 1904, of the American Society of Mechanical Engineers.

and hot-well pump. The advantage of this third type over the surface condenser systems is that it may take up less floor space, while its cost is but $5 to $6 per kilowatt. The dry-vacuum pump used with barometric condensers must have a two-cylinder air-pump, and the exhaust steam from the turbine can not be used again in the boilers.

The whole cost of a condenser system, as intimated in the opening paragraphs, is not, however, fully expressed in the contract with the condenser contractor. The turbine room is made a full third larger, and hence more expensive, by the provision of the necessary floor space, too, that is needed in the operations of the turbines. The smaller the turbine plant is, the greater this part of the cost becomes relative to that of the whole power plant.

There is, besides, a fourth type of condenser which may be used with steam turbines and to which it is the object of this paper to direct attention; namely, the injector or ejector condenser.

Within the past year the Atlantic Mills, Providence, R. I., have installed a 400-kilowatt Westinghouse-Parsons turbine. A vacuum of twenty-eight inches to twenty-eight and one-half inches is maintained on this turbine by means of the following condenser system: the exhaust steam is led, through twenty feet of vertical sixteen-inch cast-iron pipe and three short-turn elbows, into a sixteen-inch Bulkley injector condenser. The level of the ground floor is thirty-four feet below the condenser bulb, while the turbine lies on a concrete-steel floor, the level of which is twelve feet and six inches above the ground floor.

The injection water comes 500 feet from the river to the power-house, under a slight head—perhaps three feet—depending upon the state of the river. A six-inch belt-driven Lawrence centrifugal pump elevates the water into a vertical tank, thirty inches by fifteen feet deep. The level of the water in this tank is maintained by the waste pipe six inches below the water inlet nozzle on the condenser. From near the bottom of this vertical tank a seven-inch injection pipe rises up to the condenser.

A good deal of air along with the water is pumped into the top of the tank by the centrifugal pump, but apparently the depth of the tank acts efficiently as an air separator, and no air in the form of bubbles passes over into the condenser. At any rate, the vacuum shown by the mercury column is twenty-eight and one-half inches. The remarkable thing is that this is so, as nearly as the height of a mercury column can be measured, whether the column be attached to the bulb of the condenser or to the exhaust chest of the turbine.

To prove this absence of friction in the exhaust pipe a one-quarter-inch pipe was connected to the elbow above the condenser, then led down and attached to the turbine exhaust chamber. A branch horizontal pipe leads off to the mercury column. Two valves, one above and one below this horizontal pipe, enable either connection to be made at will. Starting with both valves open and the mercury quiescent, it was impossible to perceive any movement of the mercury, either up or down, after shutting either valve.

Not only is a sixteen-inch exhaust pipe thus proved ample and more than ample in size for a 400-kilowatt turbine, but the vacuum obtainable with this condenser is substantially the same, whether steam is passing through the turbine or not. The falling of the water through the "throat" is the air-pump, and is the only air-pump needed. The builders provided a twenty-inch exhaust nozzle on the turbine, but Mr. Bulkley believes that, on the contrary, a fourteen-inch condenser would do as well as the sixteen-inch.

It may be of interest to relate here a rather unusual experience, encountered when this sixteen-inch condenser was first put into service.

It was convenient to have the injection pipe rise on that side of the sixteen-inch exhaust pipe farthest from the condenser. At the top a forty-five-degree bend connected to a long-radius elbow enabled the pipe to turn and pass the exhaust pipe, approaching the condenser horizontally instead of vertically as in the usual case. Upon starting up the turbine only twenty-two inches of vacuum could be obtained. The piping was, nevertheless, proved to be absolutely tight. After shutting the injection valve Saturday afternoon with the turbine blanked off at its nozzle, and with twenty-two inches vacuum on the exhaust pipe and condenser, one found twelve inches vacuum still left on the system Monday morning before removing the blank flange in preparation for starting. Still, only twenty-two inches was the maximum height of the mercury column while running.

Finally, at the suggestion of Mr. Bulkley to the effect that in his experience he had found it necessary to have the injection pipe to his condensers approach the condenser vertically rather than horizontally for the best results, a rearrangement of the injection piping was made, permitting this vertical approach. At once, upon starting up the turbine, the result was twenty-eight and one-half inches of vacuum, and this has been maintained without interruption since. With the present load—about 300 kilowatts to 350 kilowatts—the seven-inch injection valve is open only a few turns, the temperature of the hot-well is from eighty degrees to ninety degrees, and water enough can be passed through this condenser to maintain the vacuum in summer weather. The highest degree of vacuum thus far recorded, as measured in the turbine exhaust chamber, is twenty-eight and three-quarters inches, the lowest twenty-seven and one-half inches. The variation is caused partly by changes in the barometer, but more by variable leakages in drip-valve seats. Perhaps also the amount of air entrained by the injection water varies from time to time.

The method of sealing the spindle of the Parsons turbine against air leak where it passes out of its journals from the low-pressure chambers, namely, by pumping water with centrifugal pumps formed in small recesses in the shaft cover, so as to keep a water pressure in these recesses in excess of that of the atmosphere, is a perfect success, as the experience with this condenser shows, although when but twenty-two inches could be obtained, owing to the fault in the injection pipe design described, the efficacy of these air seals was very seriously doubted.

It is interesting to note in our experience that no drip pipe or drip pump, for removing the water of condensation or the leakage into the exhaust chamber from these air seals, is found to be necessary or desirable.

It is, indeed, necessary to exclude any accumulation of water in the exhaust pipe for fear that it will sway back and forth until it flushes up on to the large low-pressure blades of the turbine. Running as they do at a very high velocity, sudden contact with water from the exhaust pipe will strip the last row off clean if such contact is permitted. Any further damage, however, to the other rotating blades seems to be prevented by the presence of the fixed row, which, by dividing up the water into small streams, seems to protect the moving rows from contact with solid water and therefore from injury.

The rate of accumulation of water leaking by the small centrifugal air-seal pumps into the exhaust pipe may be any amount up to over 950 pounds an hour. If, however, there is the least external load on the turbine, the flow of the steam

up the exhaust pipe has the power to sweep the exhaust chamber dry. The method of starting the turbine at the Atlantic Mills is to first turn on the injection water. Then admit steam to the turbine without admitting water to the air seals. After the load begins to come on, as shown by the ampere-meter, the drip pipe from the exhaust chamber to the atmosphere, which has been open all night and up to this point, is now closed, the water turned on to the air seals, and the vacuum immediately draws down to twenty-eight inches. It is not found absolutely necessary to start in this way, as the turbine can be run hours before the water accumulates in quantity. The object is simply to drain the turbine up to the moment when the load begins to come on.

If the load is a "jumping" one, from nothing to full load, there is no danger of water accumulation. It is, of course, quite possible to provide a drain receiver and pump which will work under the vacuum if it is deemed desirable to do it. There is no exhaust steam "entrainer," or water trap or seal, provided at the Atlantic Mills turbine.

The injector condenser costs, fully installed, with centrifugal circulating water pump, tank piping and valves, from $2 to $2.50 per kilowatt. This cost is much reduced if there is a natural head of water available. At the installation described, the condenser, two elbows, one tee, eighteen feet of cast-iron exhaust pipe and a fourteen-inch automatic relief valve cost, erected, $591.50. The room it occupies is practically none at all.

Theoretically considered, in its relation to turbines, the injector condenser would seem to bar out all other condenser systems in those situations where the water used in the boilers is pure in its natural state. Where it is absolutely essential to save the water of condensation for reuse as boiler-feed water, owing to the presence of salt, sulphate of lime, wool grease, acid from steel works, or other hurtful pollution, then it pays to use one of the surface condenser systems. If the city water is pure and costs about seven cents per 1,000 gallons, water enough for a 400-kilowatt machine at 100 per cent load-factor would cost per factory-year of 310 days, ten hours a day, at 1,000 gallons per hour, about $217. With interest at five per cent and fixed charges at eight per cent, this sum warrants the capital expenditure of not to exceed $1,670. It is thus clear that it does not pay to buy the surface condenser system simply to save the cost of paying city rates for boiler-feed water.

THE MAXIMUM DISTANCE TO WHICH POWER CAN BE ECONOMICALLY TRANSMITTED.[1]

BY RALPH D. MERSHON.

As transmission voltages, actual or proposed, become higher and higher and transmission distances reach out farther and farther, it is interesting and profitable to enquire into the probable maximum distance to which power will be commercially transmitted. As with most engineering enterprises the limitations will come through economic conditions, and the greatest distance to which power will ever be commercially transmitted is the greatest distance to which it can ever be economically (using the word in its broad sense) transmitted.

In endeavoring to make such a forecast, as will be here attempted, it should be borne in mind that each additional limitation consequent upon the assumptions necessary in order to obtain definite representative figures adds to the chance of the forecast proving erroneous. For instance, the first assumption which must be made is that in the future power will be transmitted in the same way as now. This may not hold. There may be devised some other and better way not involving the use of transmission lines. Such, however, does not appear probable. Other assumptions as to methods of construction being the same, as or similar to, those at present in use may be eventually so modified by skill and experience as to change very materially any conclusions arrived at now. This is less improbable. Conditions, industrial and financial, may so change that the constants now assumed as fixing costs, interest, etc., will be materially modified. This is probable. Finally, it is certain that with the course of time the value of the power will increase, and this will materially alter any figures at which we may now arrive. The present conditions of practice and possibility are sufficiently definite, however, to warrant a forecast with the expectation that it will be applicable, approximately at least, for some considerable time to come. At any rate, the method of treatment of the subject herein adopted will, with suitable changes in the values of constants, apply so long as present methods of power transmission obtain, and makes possible a comprehensive view of the possibilities of long-distance transmission.

The elements which, in the broadest sense, limit the distance to which power can be economically transmitted, are two; the cost of power at the generating station, and the price which can be obtained for the delivered power. The difference between these two elements must cover the cost of transmission, the interest on the investment, and the profit. The cost of transmission comprises the loss of power in transmission, the cost of operating, and the cost of maintenance and repair. The value of the sum total of the interest which must be paid upon the investment, and the minimum profit which is considered satisfactory, will have much weight in determining the limiting distance of transmission. The less this sum is the farther power can be transmitted; a low interest rate and a low rate of dividend will, therefore, be conducive to long transmissions.

Let us consider in a general way the manner in which the investment in a transmission plant and the annual charges and expenses in connection with the plant vary with different outputs, voltages, and distances of transmission. For a given voltage, drop, and distance of transmission, the cost of all the apparatus and equipment, except the line conductors, will increase more slowly than the output of the plant. That is, the greater the output of the plant the less the cost per kilowatt of all the equipment, except the line conductors. This will be true of the operating expenses also. Therefore, since the interest charges and the charges for depreciation and repair are dependent upon the investment, the greater the output of the plant the less will be the quantities going to make up the annual cost per kilowatt of transmitting power, except those depending upon the line conductors. Since the weight of the line conductors under the conditions assumed will vary directly as the amount of power transmitted, those elements of the annual cost per kilowatt depending upon the line conductors will be practically constant for all amounts of power transmitted and can not be materially reduced by increasing the amount of power transmitted. With the same voltage, economic drop, and output, the elements of annual cost per kilowatt due to the line structure (pole line) and to its extent (patrolling, etc.), will increase directly at the distance. But, as outlined above, any increase of cost in line structure due to increase in distance can be offset by increase of output. On the other hand, the weight of the line conductors increases as the distance (for the same economic drop) and the elements of annual cost per kilowatt due to the weight of the line conductors will, therefore, in-

[1] A paper presented at the 192d meeting of the American Institute of Electrical Engineers, New York, December 23, 1904.

crease as the distance, no matter what the output.

It appears, therefore, that all the elements in the annual cost per kilowatt for transmitting power, except those dependent upon the line conductors, may be continually reduced by increasing the amount of power to be transmitted. The annual cost per kilowatt due to the line conductors can not be so reduced. It can be diminished only by such other means as will reduce the first cost of the conductors. As the first cost of the line conductors can be reduced only by increasing the voltage of transmission and as there is a limit to which such increase can be carried, it follows that the limiting distance to which power can be economically transmitted will depend, finally, upon the cost of the line conductors and upon this alone.

The limit of voltage referred to is not necessarily that due to physical considerations, such as difficulties of construction, air losses between conductors, etc.; for, leaving such matters out of consideration,

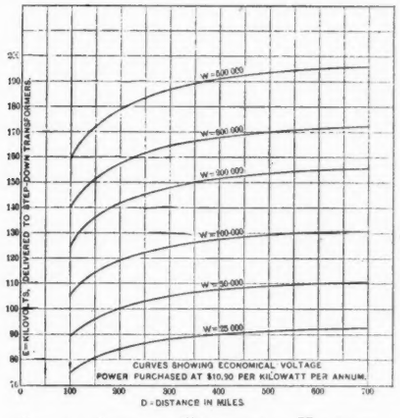


FIG 1.—SHOWING ECONOMICAL VOLTAGE.

it is easy to imagine the voltage carried to such a high value as will reduce the line conductors to the point when the increased cost of transformers and insulators, due to a further increase of voltage, will overbalance the saving in the line conductors, due to such further increase.

It will somewhat simplify the treatment of the subject if the interest charge be included as a part of the cost of transmission, and profits be represented by a percentage on the investment. This course will, therefore, be pursued. That is, it will be assumed that in the cost of transmission is included the interest on the investment (bond interest) and that over and above this cost there must be earned a certain percentage, which percentage will represent profits (stock dividends). In addition the following assumptions will be made:

Power purchased at low-tension busbars to step-up transformers and sold at outgoing bus-bars of the step-down station.

Frequency of transmission not less than twenty-five cycles nor more than thirty cycles as being the limiting frequencies

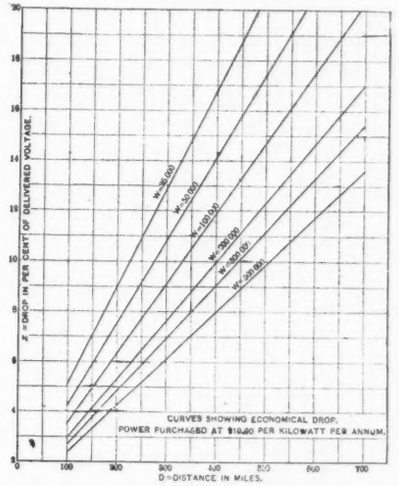


FIG. 2.—SHOWING ECONOMICAL DROP.

which, while favorable to the transmission of power, are yet suitable for almost all purposes to which power can be applied.

Idle synchronous motors at step-down station to correct for power-factor, the average power-factor of the line being held as near unity as possible. In the plants of large output dealt with below, the possible approximation to unity power-factor will, in spite of the line-charging current, be sufficiently close, for practical purposes, to justify the assumption of unity power-factor.

That no matter what the capacity of the

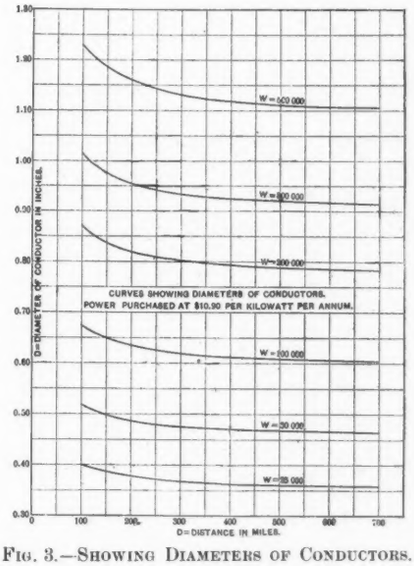


FIG. 3.—SHOWING DIAMETERS OF CONDUCTORS.

plant, there will be three transmission lines, each capable of carrying one-third the load.

That the power-factor of the load supplied will be 0.8.

That no matter what the size of the plant the number of transforming units at each end of the line be eighteen, each transformer being normally worked at five-sixths of its rated capacity, so that one bank of three may be cut out, if need be.

That no matter what the size of the plant the number of corrective synchronous motors will be six, each being worked at five-sixths of its rated capacity. The kilovolt-ampere capacity of these synchronous motors must, for a load power-factor of 0.8, be equal to three-fourths of the kilowatt capacity of the load carried by the plant.

It is evident that the number of units must be considered as the same for plants of all capacities in order to take full advantage of the decrease of cost per kilowatt, due to increase of capacity.

The pole lines will be assumed as con-

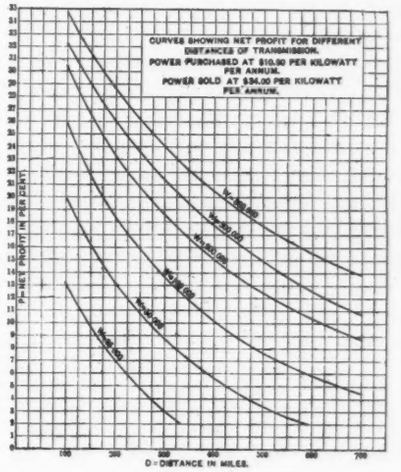

P=NET PROFIT IN PER CENT.
CURVES SHOWING NET PROFIT FOR DIFFERENT DISTANCES OF TRANSMISSION.
POWER PURCHASED AT $10.90 PER KILOWATT PER ANNUM.
POWER SOLD AT $24.00 PER KILOWATT PER ANNUM.
W=500 000
W=300 000
W=200 000
W=100 000
W=50 000
W=30 000
D=DISTANCE IN MILES.

FIG. 4.—NET PROFIT FOR DIFFERENT TRANSMISSION DISTANCES.

structed with twelve steel towers to the mile.

Ideal conditions will be assumed throughout consistent with delivering reliable and cheap power. Since the object is to determine the maximum distance, the factors fixing commercial costs of apparatus will be taken at the lowest values likely to obtain.

Later on in this paper general equations are derived expressing the relations between the distance of transmission and the quantities which govern it. By making assumptions, in addition to those mentioned above, as to the values of the various coefficients in the general equations and as to the purchase price and selling price of power, the curves of Figs. 1, 2, 3, 4, and 5 have been obtained which are given and discussed here instead of at the end of the paper.

Fig. 1 shows the relation between the distances of transmission D and the

economical voltage E for different kilowatt outputs W; that is, it shows the voltage which it is most economical to use for any given output and distance of transmission.

Fig. 2 shows, in a corresponding manner, the economical drop.

Fig. 3 shows the diameter of the conductors corresponding to the conditions of Figs. 1 and 2.

Fig. 4 shows the relation between D, the distance of transmission, and *p*, a percentage net profit on the investment for different values of output W, and for selling price of thirty-four dollars per kilowatt per annum.

Fig. 5 is a curve obtained from Fig. 4 and shows the relation between the distance of transmission and the output for a net profit of twelve per cent.

In obtaining these curves the constants have all been given values favorable to long transmission distances. The costs have been taken lower than those ordinarily current in the endeavor to anticipate somewhat possible future prices. Also, the cost of power purchased at the step-up station has been fixed at the very low figures of $10.90 per kilowatt per annum. These facts should be carefully borne in mind in considering the curves, which will all be more or less modified by changes in the quantities mentioned.

On comparing the diameters of conductors given by Fig. 3 and the voltages to which they correspond with the values of diameter and critical voltage given by Professor Harris J. Ryan in his splendid paper on that subject,[1] it appears that the diameters of Fig. 3 are considerably above those of the paper mentioned. The values of Fig. 3 are affected by the price paid for power at the step-up transformers, but if this be taken even as high as $20 per kilowatt per annum instead of $10.90, the diameters of the conductors remain below those for the critical voltages. It appears, therefore, in the light of present knowledge that the limit of voltage will come through economic conditions and not through conditions depending upon atmospheric losses.

It is difficult to fix upon a figure for the selling price of the delivered power which shall be representative. Power prices are so dependent upon conditions, especially those arising from the location and magnitude of the market and of the supply, that any figure chosen will be objected to by some as too high and by others as too low. The same condition applies to the price assumed as that paid for power at the step-up station but in a lesser degree. The figure herein assumed as the price of the power sold, thirty-four dollars per kilowatt per annum, is that which seems to the writer will be fairly representative, especially in the case of the large blocks of power. The writer does not, however, wish to be understood as committed to an opinion by the power prices herein, either in the case of purchase or of sale. The values taken have been chosen as being as nearly representative as possible of the best conditions which might obtain, favorable to long-distance transmission. If these figures should be criticised in about equal proportions from the standpoints of being too low and too high, respectively, the object in choosing them will have been accomplished, since such criticism will be evidence of their fairness as a reasonable compromise.

The voltages to which the curves apply are much higher than those now in use commercially, but they are not beyond the range of future possibility. Manufacturers will now undertake commercial transformers for voltages as high as 150,000 volts, and there is little question that when the demand shall come for units of the large capacities contemplated herein, the voltage requirements will be met. Such transformers will be structures of sufficient size to permit of being got at and worked upon from the inside as well as the outside and this, in connection with the fact that more space may be utilized for insulation, will render construction for high voltages much less difficult than at present.

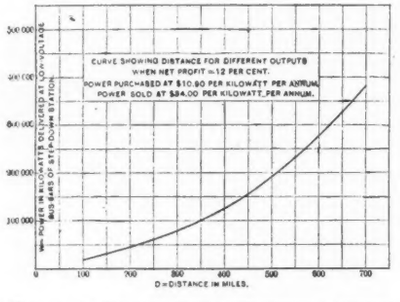

CURVE SHOWING DISTANCE FOR DIFFERENT OUTPUTS
WHEN NET PROFIT = 12 PER CENT.
POWER PURCHASED AT $10.90 PER KILOWATT PER ANNUM.
POWER SOLD AT $34.00 PER KILOWATT PER ANNUM.
D=DISTANCE IN MILES.

FIG. 5.—DISTANCE FOR DIFFERENT OUTPUTS AT TWELVE PER CENT PROFIT.

The maximum amount of power dealt with herein, 500,000 kilowatts, is probably too high to be seriously considered at this time, but from 200,000 to 300,000 kilowatts is believed to be within the range of immediate future possibility. In a plant of this size it is probable that a net return of twelve per cent would be required, not alone for the purpose of dividends, but also as a protection to the bonds. Under these conditions Fig. 5 shows the distance of transmission to vary from 512 miles for 200,000 kilowatts to 623 miles for 300,000 kilowatts. For the present outlook, therefore, the limiting distance may be taken as about 550 miles.

It appears from the preceding matter that under the conditions assumed, the limiting distance of transmission will, for some time at least, be in the neighborhood of 550 miles.

It also appears that voltage limits will be fixed not by conditions depending upon atmospheric losses, but by economic conditions.

The latter conclusion, while recognized as a possibility when this paper was begun, was unexpected. It is, perhaps, of greater present importance than the original object of the paper as conveyed in the title.

The analysis on which depends the general equations from which the preceding curves were obtained will now be taken up.

Let E = voltage, in kilovolts, delivered to step-down transformers.
D = distance of transmission in miles.
x = percentage of power lost in the line in terms of delivered power.
e = efficiency of the whole system.
e_1 = combined efficiency of step-up and step-down transformers and synchronous motors.
d = diameter of line conductors in inches.
W = power, in kilowatts, delivered at low-voltage bus-bars of step-down station.
c = cost, in dollars per kilowatt per annum of power purchased at the low-voltage bus-bars of the step-up transformers.
Let s = price, in dollars, received for power per kilowatt per annum at the low-voltage bus-bars of the step-down station.
h = a quantity which, multiplied by c, will give the cost at the high-voltage terminals of step-up transformers.
R = total interest maintenance and depreciation charge per annum.
L = cost of labor for operating transformer stations and for executive and clerical services.
M = total investment.

[1] See paper read by Professor Ryan before American Institute of Electrical Engineers, February 26, 1904.

C = total cost per annum of power delivered, inclusive of interest.
p = a percentage covering profit.

$\therefore \quad e = \frac{e_1}{1+x}$, since $\frac{1}{1+x}$ is the efficiency of the line.

$\therefore \quad \frac{W c}{e} = \frac{W\ c\ (1\ +\ x)}{e_1}$ = total amount expended per annum for power purchased.

$\therefore \quad W s$ = total amount received per annum for power.

$$\therefore \quad C = \frac{W c}{e} + L + R$$

$$\therefore p = \frac{W s - C}{M} = \frac{W s - \frac{W c}{e} - L - R}{M} =$$

$$\frac{W s - \frac{W c (1 + x)}{e_1} - L - R}{M} = \frac{N}{M} \quad (1)$$

Now M is made up of

1. Cost of transformers.
2. Cost of transformer switchboard apparatus, cables, lightning protection, etc.
3. Cost of building and real estate.
4. Cost of insulators.
5. Cost of pole-line material and construction.
6. Cost of right of way.
7. Cost of corrective synchronous motors and exciters.
8. Cost of switchboard apparatus, cables, etc., for synchronous motors.
9. Cost of line conductors.

Cost of transformers will depend upon voltage and output;

f_1 (E,W)

Cost of transformer cables and controlling apparatus will depend upon same quantities as transformers, but in a different way;

f_2 (E,W)

Cost of building will depend upon output;

f_3 (W)

Cost of insulators will depend upon voltage, diameter of conductors and number required; *i. e.*, voltage, diameter of conductor, and distance of transmission;

f_4 (E,d,D)

Cost of pole-line construction will depend upon diameter of the conductors and the distance. But the diameter of the conductors depends upon voltage, drop, output, and distance; hence,

f_5 (d, D) = f_5 (E, W, x, D)

Cost of right of way will depend upon distance only;

f_6 (D)

Cost of synchronous motors will depend upon output only, since all other elements affecting cost will be fixed;

f_7 (W)

Cost of switchboards and cables for synchronous motors will depend upon output only;

f_8 (W)

Cost of line conductors will depend upon voltage, output, line loss allowed, and distance of transmission;

f_9 (E, W, x, D)

The sum of these nine functions constitutes M, the total investment.

Now R, the total interest and depreciation charge, depends upon all of the several quantities making up M.

In what follows the numerical value of the constants are those taken for the specific problem treated herein.

Let p_1 = 0.125, being the percentage of transformer cost for interest, depreciation, and repairs.
p_2 = 0.125, being the percentage of transformer switchboards cost for interest, depreciation and repairs.
p_3 = 0.075, being the percentage of buildings, cost for interest, depreciation, and repairs.
p_4 = 0.10, being the percentage of insulator cost for interest, depreciation, and repairs.
p_5 = 0.125, being the percentage of pole-line cost for interest, depreciation, and repairs.
p_6 = 0.05, being the percentage of cost of right of way, for interest only.
p_7 = 0.125, being the percentage of synchronous motor cost of interest, depreciation, and repairs.
p_8 = 0.125, being the percentage of cost of synchronous motor, switchboard, etc., for interest, depreciation, and repairs.
p_9 = 0.05, being the percentage of cost of conductors, for interest.
R = the sum of these percentages multiplied respectively into the several quantities to which they refer.

L depends only upon output

f_{10} (W)

The numerical values given for the percentages p_1, p_2, etc., are those which will be used in the specific problem herein treated. The rate of interest has in all cases been taken as 0.05, so that by subtracting this from the above values the depreciation assumed in each case may be determined.

If there be substituted in equation (1) the values of M, L, and R, as expressed by the above symbols, there will result an equation expressing in the most general terms the relations between the distance of transmission and the quantities which govern it. This substitution results in rather an unwieldy expression and will be omitted.

Before proceeding with the determination of the forms of the several functions indicated it will be necessary to enter into a discussion of the relations existing between voltage and line loss, and the quantities governing them respectively.

Let q = that portion of the cost per kilowatt at the low-tension bus-bars of the step-down station, which is due to line loss and to interest on the value of the conductors; then, anticipating in part the matter of a few pages further on

$$q = \frac{p_9 K_9 \frac{W D^2}{E^2 x} - h c W x}{W}$$

in which $p_9 K_9 \frac{W D^2}{E^2 x}$ is the interest on the conductors and $h c W x$ the cost of the power lost in the line.

Setting the first derivative of this with respect to x equal to zero, in order to determine the value of x corresponding to the minimum value of q, we find the well-known expression for economic drop

$$x = \left(\frac{p_9 K_9}{h c}\right)^{\frac{1}{2}} \frac{D}{E} = n \frac{D}{E} = 0.038 \frac{D}{E} \quad (2)$$

From this equation for x we may obtain the equation

$$p_9 K_9 \frac{D^2}{E^2 x} = h c x$$

But the first member of this equation is the interest on the line conductors per kilowatt delivered, and the second member is the annual cost of the line loss per kilowatt delivered. That is, for most economical conditions the line loss per kilowatt delivered must be equal in value to the interest on the conductors per kilowatt delivered—a relation already well known.

As has already been suggested, there will be a limit to which the voltage can be carried, due to the fact that, although increase of voltage will diminish the annual cost of lost power and of conductors, it will increase the annual cost of certain other important factors. The elements of annual cost which are affected by change of voltage are the interest and depreciation of the transformers, the interest on the line conductors, the line loss, and the interest and depreciation of the insulators. The first and last items will increase with the voltage, because of the

increased first cost, due to the increase of voltage; the other two will diminish.

Let $q_1 =$ that portion of the annual cost per kilowatt of delivered power due to the line loss, conductors, insulators, and transformers. It has just been shown that for best economy the line loss and annual conductor cost must be equal, so that twice the line loss, $2\,h\,c\,W\,x$, may be taken as representing the sum of the annual cost due to line loss and to the conductors. As will be shown later, the cost of the insulators will vary as the distance of transmission, and as the cube of the voltage, and the cost of the transformers may be represented by

$$K_1'\,(E + K_1'')\,W^{\frac{1}{2}}$$

Hence remembering that p_1 and p_4 are the interest and depreciation of transformers and insulators, respectively,

$$q_1 = \frac{2\,h\,c\,W\,x + p_4\,K_4\,E^3\,(1 + x)^3\,D + p_1\,K_1'\,(E + K_1'')\,W^{\frac{1}{2}}}{W}$$

or, putting in the value of $x = \left(\frac{p_9\,K_9}{h\,c}\right)^{\frac{1}{2}}\frac{D}{E} = n\,\frac{D}{E}$.

$$q_1 = \frac{2\,h\,n\,WDE^{-1} + p_4\,K_4\,E^3\,(1 + n\,DE^{-1})^3\,D + p_1\,K_1'\,(E + K_1'')\,W^{\frac{1}{2}}}{W}.$$

Now if the first derivative of q_1 with respect to E be set equal to zero to determine the best value of E, there results a quartic equation more interesting than valuable, so far as the present purpose is concerned. It will greatly simplify matters if instead of substituting the value of x in $(1 = x)^3$ we substitute for x, x^1, a fixed drop of such value as will correspond to the average cost of insulator between the two extreme values of x which will be met with in practice; as will be shown later, the error due to such a course will be small. Hence

$$q_1 = \frac{2\,h\,c\,n\,WDE^{-1} + p_4\,K_4\,E^3\,(1 + x_1)^3\,D + p_1\,K_1'\,(E + K_1'')\,W^{\frac{1}{2}}}{W}.$$

Setting the first derivative of this equation equal to zero, solving and substituting the value $n = \left(\frac{p_9\,K_9}{h\,c}\right)^{\frac{1}{3}}$ there results

$$E = \left(\frac{-\,p_1\,K_1'\,W^{\frac{1}{2}}}{6\,p_4\,K_4\,(1 + x_1)^3\,D} + \sqrt{\frac{p_1^2\,K_1'^2\,W}{36\,p_4^2\,K_4^2\,(1 + x_1)^6\,D^2} + \frac{2\,(h\,c\,p_9\,K_9)^{\frac{1}{3}}\,W}{3\,p_4\,K_4\,(1 + x_1)^3}}\right)^{\frac{1}{3}}$$

$$= \left(-\,3{,}066\,\frac{W^{\frac{1}{2}}}{D} + \sqrt{9{,}400{,}356\,\frac{W}{D^2} + 3{,}438.5\,W}\right)^{\frac{1}{3}} \qquad (3)$$

This shows that the voltage may be increased with increase of output, which was to be expected since those costs which limit the voltage will diminish in their amount per kilowatt as the output increases. The value of x_1 used in the above equation was determined upon as follows: the minimum percentage drop which is ever likely to obtain is, say, 2.2, the maximum is, say, 11.5. The reason for selecting these values will be apparent on considering the values of E calculated from the above equation, and given below, in connection with the values of W to which they correspond, and the respective distances to which in each case the various amounts of power would probably be transmitted. The intermediate value of drop which will give the average insulator cost is 6.45 per cent, and this value of x_1 is taken. With this value of x_1 the maximum error in insulator cost, between the limits assigned, will have place when $x = 2.2$ and $x = 11.5$. The percentage error at either of these limits is about thirteen per cent. But, as appears in the solution of the first derivative, at the point of minimum of the variables affected by the voltage the combined values of the annual cost due to the conductors, the annual cost of the line loss, and that portion of the annual transformer cost due to voltage, is more than three times that due to the insulators. The total variable quantity involved, therefore, is more than four times the annual cost due to insulators, and the error as a percentage of the total of values of the variables involved is less than $\frac{13}{4} = 3.25$, instead of thirteen per cent. As will be seen on examining the manner in which x_1 enters the equation for E, the maximum error in E will be less than three per cent, also which will to a like extent affect the values of x. This error is negligible so far as the main problem is concerned, and indeed as far as the question of voltage itself is concerned.

In Fig. 1 are shown curves plotted from equation (3). These curves show the kilovolts E for different distances D, and different outputs W. Fig. 2 gives curves plotted from equation (2), using the values obtained from the curves of Fig. 1. The curves of Fig. 2 show the percentage drop x for different distances D, and different outputs W. In Fig. 3 are curves showing the diameters of the conductors for the conditions of Figs. 1 and 2. These diameters were calculated from the formula

$$d = k_5'\left(\frac{WD}{E^2\,x}\right)^{\frac{1}{3}} = k_5'\left(\frac{WD}{E^2}\cdot\frac{E}{n\,D}\right)^{\frac{1}{3}} = \frac{k_5'}{n^{\frac{1}{3}}}\left(\frac{W}{E}\right)^{\frac{1}{3}} = 0.0219\left(\frac{W}{E}\right)^{\frac{1}{2}} \qquad (4)$$

which gives the diameter d, in inches, of a solid conductor. These diameters were in this case calculated for a solid conductor instead of a stranded one because we have at present available data as to the critical point in the atmospheric loss curve for solid conductors only, and while perhaps this critical point will come at a higher voltage in the case of the stranded conductor with its greater diameter, there are no definite data at present on the subject. On comparing the diameters of conductors given by Fig. 3 and the voltages to which they correspond with the values of diameter and critical voltage given by Professor Ryan[1] we see that the diameters of Fig. 3 are considerably above those of Professor Ryan's paper. It appears, therefore, from the present knowledge available, that the limit of voltage will come through economic conditions, and not through limitations connected with atmospheric losses.

In the determination of both x and E the quantity h has been employed. This quantity is a factor which, when multiplied into the cost of power at the low-tension bus-bars of the step-up transformers, will give the cost of power at the high-tension terminals of the transformers. That is to say, h takes account of all charges which should be made against this power, including interest and depreciation of the step-up station, transformers, etc., and labor for operating the station, also the loss in the transformers. Now, strictly, there should be substituted for h, the proper functions of the quantities on which it depends, but to do so would seriously complicate the equations and would be of little utility, since h can be approximated with sufficient accuracy in any particular case, and the manner in which it occurs in both x and E is such as to make the error in the quantities due to an error in h much smaller than the error in h itself. In the specific problem herein the value $c = 10.9$ is taken as being the lowest which will probably ever obtain, where large amounts of power are

[1] See footnote, page 1094.

available within transmission distance of a desirable market. The value taken for h in the determination of E and x is $h = 1.1$, so that $h\,c = 12$.

The next step is the determination of the forms of the several functions indicated. In what follows the constants have been evaluated for the specific problem herein. The costs resulting from the use of these constants will be found to be, in general, considerably less than present commercial costs. The constants were purposely based on prices less than can be now obtained, in the endeavor to anticipate, somewhat, possible future prices.

From a careful consideration of transformer prices, it has been determined that, for transformers of 1,500 kilowatts and over, the cost installed very closely follows the law,

$$f_1(E, W) = K_1'(E + K_1'')W^{\frac{1}{2}} = 13.\ (E + K_1'')W^{\frac{1}{2}},$$

$$\therefore p_1 f_1(E, W) = p_1 K_1'(E + K_1'')W^{\frac{1}{2}} = 1.625\,(E + K_1'')W^{\frac{1}{2}}$$

in which K_1' is a constant and K_1'' a "variable constant," a quantity which varies slowly with the output in accordance with the law,

$$K_1'' = k_1 + k_1''W = 55 + 0.000227\,W$$

Theoretically the transformer cost would vary with the drop x_1, since the step-up transformers would have an output and voltage greater than the step-down transformers. Practically, however, step-up and step-down transformers are built so nearly in the same lines that the drop would make little difference. Such difference as would exist can be taken care of approximately by adjustment of the constants, which has been done.

While the apparatus for the control of the high-tension side of the transformers would theoretically vary with the voltage, such variation for 50,000 volts and over will be small, since in most modern plants the high-tension switching apparatus is simple; and higher voltages are likely to cause it to remain so. The lightning protection for the high-voltage lines might vary with the voltage, but it is probable that for high voltages there will soon be a reversion to much simpler and inexpensive apparatus than we use now, so that the variation, if any, due to higher voltages, will be negligible. The switchboard for the lower voltage side of the transformers will vary only with the output, since we assume the lower voltage to be the same in all cases, say 6,000 volts or thereabouts. The apparatus for the control of transformers may, therefore, be considered as depending only upon output. Under this assumption a consideration of costs of transformers, controlling apparatus and cables, shows that we may assume, with a close degree of accuracy, that

$$f_2(E, W) = K_2' + K_2''W = 21{,}000 + 0.9\,W$$

$$\therefore p_2 f_2(E, W) = p_2 K_2' + p_2 K_2''W = 2{,}625 + 0.1125\,W$$

The cost of buildings and the real estate for them will increase very slowly with the output. The variation of this item due to variation of output can be expressed closely enough by

$$f_3(W) = K_3' + K_3''W^{\frac{1}{2}} = 125{,}000 + 125\,W^{\frac{1}{2}}$$

$$\therefore p_3 f_3(W) = p_3 K_3' + p_3 K_3''W^{\frac{1}{2}} = 9{,}375 + 9.375\,W^{\frac{1}{2}}$$

The cost of an insulator will, theoretically, vary with the diameter of the conductor and the voltage. Practically, however, the diameter of the conductor will have nothing to do with the cost. A consideration of insulator prices shows that the cost of an insulator will vary as the sum of a small constant plus the product of a constant into the cube of the voltage. With high voltages the small constant is negligible, so that we may write

$$f_4(E, d, D) = K_4 E_3 (1 + x_1)^3 D = 0.000732\,(1.0645)^3 E^3 D = 0.000883\,E^3 D.$$

$$\therefore p_4 f_4(E d D) = p_4 K_4 E^3 (1 + x_1)^3 D = 0.0000883\,E^3 D$$

The cost of the pole-line material and construction will depend somewhat upon the diameter of the conductors, since, as the diameter of the conductors increases, the wind and sleet stresses will increase. The increase of cost with increase in diameter of conductors will be slow. The law followed will be that of a constant plus a function of the diameter of conductors, since, no matter how small the diameter of conductor, there will be a certain cost representing the minimum sized pole which would be employed. We may, with a fair degree of accuracy, write

$$f_5(d, D) = (K_5' + K_5''d)D =$$

$$f_5(E, W, X, D) = K_5' D + K_5'' k_5 \left(\frac{WD}{E_2 x}\right)^{\frac{1}{2}} D$$

or, putting in the value of $x = n\,\frac{D}{E}$

$$f_5(E, W, x, D) = K_5' D + \frac{K_5'' k_5}{n^{\frac{1}{2}}}\left(\frac{W}{E}\right)^{\frac{1}{4}} D = 3{,}000\,D + 37.2\left(\frac{W}{E}\right)^{\frac{1}{4}} D$$

$$\therefore p_5 f_5(E, W, x, D) = p_5 k_5' D + p_5 \frac{k_5'' x_5}{n^{\frac{1}{2}}}\left(\frac{W}{E}\right)^{\frac{1}{4}} D = 375\,D + 4.65\left(\frac{W}{E}\right)^{\frac{1}{4}} D$$

which answers for a stranded conductor.

Cost of right of way will be directly proportional to distance, hence

$$f_6(D) = K_6 D = 1{,}000\,D$$

$$\therefore p_6 f_6(D) = p_6 K_6 D = 50\,D$$

A consideration of synchronous motor prices shows that the cost of synchronous motors may be written,

$$f_7(W) = K_7' + K_7''W = 12{,}000 + 32.4\,W$$

$$\therefore p_7 f_7(W) = p_7 K_7' + p_7 K_7''W = 1{,}500 + 4.05\,W$$

From the well-known relations between the cost of conductors, and the voltage distance, output, and drop, we may write

$$f_9(E, W, X, D) = K_9 \frac{WD^2}{E^2 x} = 0.346\,\frac{WD^2}{E^3 x}$$

or, putting in the value of $x = n\,\frac{D}{E}$

$$f_9(E, W, X, D) = K_9 \frac{WD}{E n} = \frac{K_9}{n}\cdot\frac{WD}{E} = 9.1\,\frac{WD}{E}$$

$$\therefore p_9 f_9(E, W, X, D) = p_9 K_9 \frac{WD}{E n} = 0.455\,\frac{WD}{E}$$

The cost of labor, for the operation of the step-up and step-down transformer stations, and for executive and clerical purposes, would probably not vary at all. We have, in each case, the same number of units to be looked after, and the size of these units would make little, if any, difference in the cost of attendance upon them. Similarly, the output will make little difference in executive and clerical costs. We would probably be justified in making $f_{10}(W)$ a constant. In order, however, to cover such small increase in labor and salaries as there might be with increase of output we will write

$$f_{10}(W) = K_{10}' + K_{10}''W^{\frac{1}{2}} = 32{,}000 + 23\,W^{\frac{1}{2}}$$

It is noted t' at the labor in connection with the line is taken care of in the depreciation and repair percentages applicable to the supporting structure and insulators respectively.

The efficiency of the whole system is

$$\frac{e_1}{1 + x}$$

Putting in the value of $x = n\,\frac{D}{E}$

$$e = \frac{e_1}{1 + n\,\frac{D}{E}} = \frac{0.925}{1 + 0.038\,\frac{D}{E}}$$

$$\frac{W c}{e} = \frac{W\left(1 + n\,\frac{D}{E}\right)c}{e_1} = \frac{W c}{e_1} + \frac{n c}{e_1}\cdot\frac{WD}{E} = 11.78\,W + 0.448\,\frac{WD}{E}$$

The various functions above arrived at

may now be utilized in obtaining N and M of equation (1), $p = \frac{N}{M}$.

Remembering that R is the sum of the products of the various functions by the corresponding percentages representing interest, depreciation, and repair; that $L = f_{10}(W)$, and representing the various resulting collections of constants as follows:

$$a = p_2 K_2'' + p_7 K_7'' + p_8 K_8'' = 4.184$$
$$b = K_{10}' + p_2 K_2' + p_3 K_3' + p_7 K_7' + p_8 K_8' = 46,550$$
$$m = K_{10}'' + p_3 K_3'' = 35.38$$
$$r = p_5 K_5' + p_6 K_6 = 425$$

$$\text{then } N = W s - \frac{W c (1+x)}{e_1} - L - R$$

$$(s - \frac{c}{e_1} - a) W - \left(\frac{n c}{e_1} + \frac{p_9 K_9}{n}\right) \frac{WD}{E} - m W^{\frac{1}{2}} - p_1 K_1' (E + K_1'') W^{\frac{1}{2}} - p_4 K_4 (1+x_1)^3 E^3 D - r D - \frac{p_5 K_5'' k_5}{n^{\frac{1}{2}}} \frac{W^{\frac{1}{2}}}{E} D - b.$$

Representing constants as follows:

$$\alpha = K_2'' + K_7'' + K_8'' = 33.47$$
$$\beta = K_2' + K_3' + K_7' + K_8' = 166,400$$
$$\gamma = K_5' + K_6 = 4,000$$

$$M = \alpha W + \frac{K_9}{n} \cdot \frac{WD}{E} + K_3'' W^{\frac{1}{2}} + K_1' (E + K_1'') W^{\frac{1}{2}} + K_4 (1+x_1)^3 E^3 D + \gamma D + \frac{K_5'' k_5}{n^{\frac{1}{2}}} \cdot \frac{W^{\frac{1}{2}}}{E} D + \beta.$$

These values of N and M, if substituted in equation (1) will give, in its final form, the equation connecting distance, output, voltage, and profit, or, in connection with equation (3), for voltage, the relation between distance, output and profit. Such substitution results in a cumbersome equation and will not be made here. If the various numerical values, already determined for the specific problem herein treated, be substituted in N and M, there results:

$$N = (s - 15.96) W - 0.903 \frac{WD}{E} - 35.38 W^{\frac{1}{2}} - 1.625 (E + K_1'') W^{\frac{1}{2}} - 0.0000883 E^3 D - 425 D - 4.65 \left(\frac{W}{E}\right)^{\frac{1}{2}} D - 46,550$$

$$M = 33.47 W + 9.1 \frac{WD}{E} + 125 W^{\frac{1}{2}} + 13 (E + K_1'') W^{\frac{1}{2}} + 0.000883 E^3 D + 4,000 D + 37.2 \left(\frac{W}{E}\right)^{\frac{1}{2}} D + 166,400.$$

The value of s in the above equation for N is taken as 34, that is, it is assumed, for the purposes of the specific problem, that power is sold at $34 per kilowatt. Putting in this value of s and calculating the value of p for different outputs W, and different distances D, the curves of Fig. 4 have been obtained. These curves show, for different values of W, the relation between p and D. Assuming that the minimum acceptable profits is twelve per cent, and taking from Fig. 4 the values of D and W corresponding to this percentage profit, there has been plotted the final curve, Fig. 5, which shows the relation between distance and output.

In considering these curves, the assumption made in connection with them should be carefully borne in mind. A small change in the purchase price or selling price of power will make a great difference in the result. Smaller amounts of power will in general be purchased at a higher price per kilowatt, but on the other hand they would probably be transmitted to points where the power would bring a higher price, since in general, the larger the market the cheaper can power be produced by steam.

It would be interesting to let $s - c/e_1$ equal to zero and determine p which would then be the cost, including interest, of operating the plant. If curves showing the percentage of the investment for operation were thus determined, also the total cost of the plant, both for various outputs, the results would be valuable in preliminary estimates. The writer hopes to work up such data later.

It will be noticed on referring to the curves that some of them reached to distances which caused the drop to exceed the value taken for the upper limit of drop in connection with insulator cost. The error due to one or two per cent excess will not greatly affect the final result. It would have been somewhat better, however, for the specific problem treated, to have chosen the limits of drop as five per cent and ten per cent respectively instead of those taken.

BOOK REVIEWS.

"Electrical Engineers' Pocketbook." Horatio A. Foster. New York. D. Van Nostrand Company. Leather. 991 pages. 4 by 7 inches. Illustrated. Supplied by the ELECTRICAL REVIEW at $5.

This is the third edition and thirteenth thousand of this well-known handbook.

"Small Electrical Measuring Instruments." Model Engineer Series No. 24. London. Percival Marshall & Company. Paper. 90 pages. 5 by 7 inches. 59 illustrations. Supplied by the ELECTRICAL REVIEW at 25 cents.

This book gives directions for making apparatus for small testing instruments. The designs and descriptions have appeared from time to time in the *Model Engineer*, and although of a simple and inexpensive character, are intended to be practical instruments.

"Steam Turbines." H. H. Harrison. London. Percival Marshall & Company. Paper. 85 pages. 5 by 7 inches. 74 illustrations. Supplied by the ELECTRICAL REVIEW at 25 cents.

This is No. 23 of the Model Engineer series, and consists principally of articles which have appeared in the *Model Engineer*. The first two chapters are devoted to a theoretical consideration of the action of steam in a jet. The body of the book consists of a description of the method of designing a De Laval turbine. The last chapter takes up the theory of multiple-stage turbines.

"Elements of General Draughting for Mechanical Engineers." C. E. Coolidge and H. L. Freeman. New York. John Wiley & Sons. Cloth. 51 pages. 9½ by 12½ inches. 21 folding plates. Supplied by the ELECTRICAL REVIEW at $2.50.

This book was specifically written for the use of students in the sophomore class of Sibley College, Cornell University, and for students in manual training schools, trade schools and technical colleges. It consists of a course in drawing, describing the work taken up, and a manual of drawing which gives directions for drawing the various plates contained in the book. The course comprises five grades. The first two grades comprise details, and the third and fourth are assembly drawing of finished machines. The fifth grade is devoted to perspective and patent office drawing.

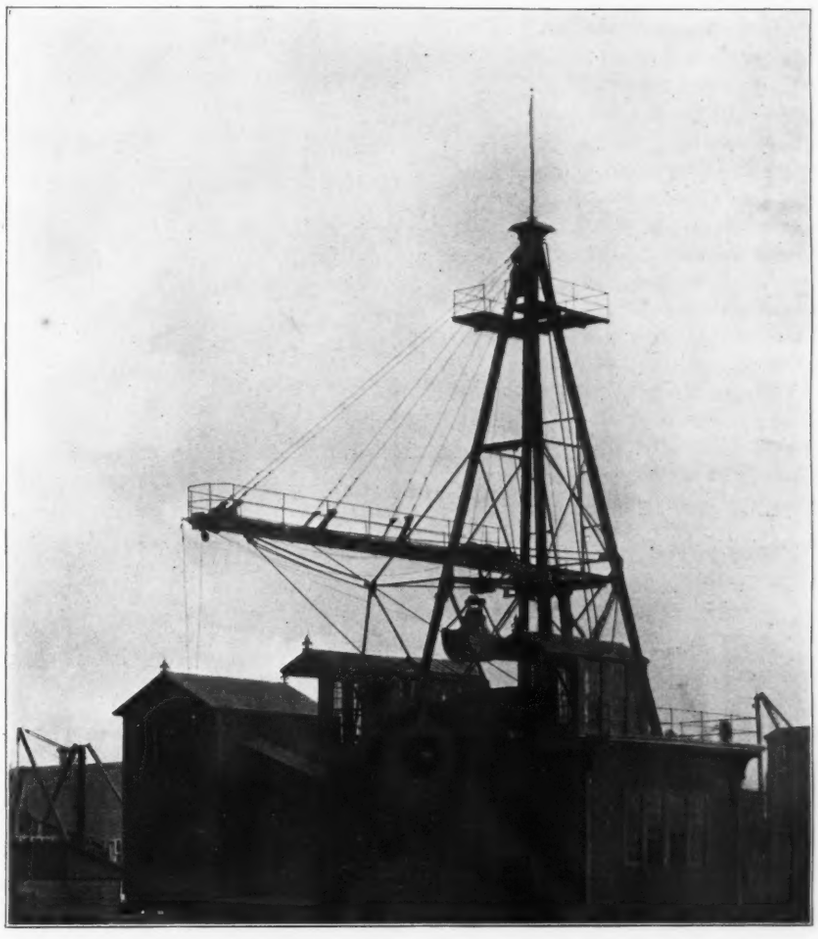
"The Naval Constructor." George Simpson. New York. The D. Van Nostrand Company. Leather. 588 pages. 4 by 6 inches. 288 illustrations. Supplied by the ELECTRICAL REVIEW at $5.

This book is intended as a reference book for those engaged in the design and construction of ships. It contains a large quantity of new and original matter, including a chapter on design, and tables of standardized fittings, details, etc. The book is divided into seven sections. The first section is devoted to ship calculations. It treats of the displacement, buoyancy, stability, the preparation of specifications, launching, strength of ships, and speed and power of vessels. The second section takes up strength of materials used in the construction of vessels, including timber and structural sections. The third section describes fittings and details, such as keels, rudders, framing, bulkheads, etc. Rigging and the ropes of a vessel are described in section four, and section five gives dimensions of the various minor equipments of a vessel, including anchors, small boats, etc. It also gives the Board of Trade requirements, the supervising inspector's requirements, and the yacht racing rules of the New York Yacht Club and Yacht Racing Association. Sections six and seven are devoted to mathematical tables and tables of materials.

The Coal-Handling Plant of the Power-House of the Interborough Rapid Transit Company.

WITH the evolution of large steam power stations and the demand for continuous outputs of many units the coal and ash-handling problem has called for the exercise of a great deal of engineering ability. There must be supplied ample storage capacity within the power building proper, so situated that fuel may be continually apportioned to each one of the boilers under operation. Notwithstanding the large amount of room which has been given to the storage of fuel in the modern power station, it has been found that there must be no prolonged delay in the supply of fuel to this storage area from outside sources. Within recent years there have been devised several forms of apparatus for the continuous transport of fuel from the point of delivery outside of the power-house to the furnace door. These coal-handling systems have been accompanied by ash-handling apparatus, working on very much the same principle, which remove the ash and clinker automatically.

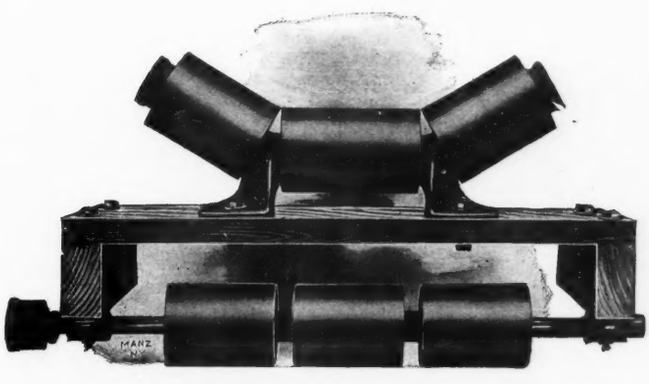
The power plant of the Interurban Rapid Transit Company, located between Fifty-eighth and Fifty-ninth streets, and fronting on the North river, New York city, represents the most recent refinement in power-station design. The coal and ash-handling equipment at this station was the subject of lengthy consideration, as it was desired to install a system which would make unnecessary a reserve unit. The success attained by the Robins system early attracted the attention of the engineers of the Interborough Rapid Transit Company, and it was decided to install this system to take care of the entire problem of handling the coal and ashes.



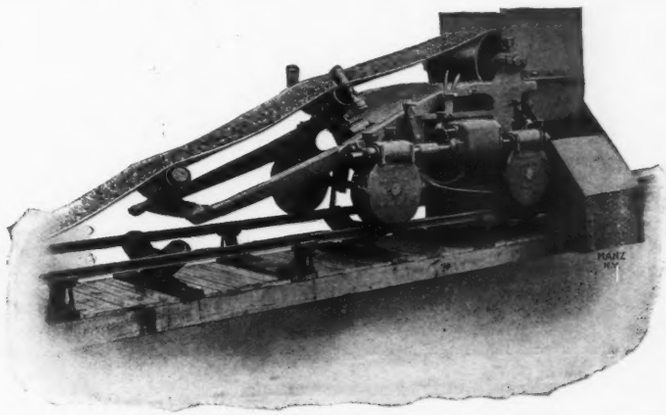
COAL-HANDLING TOWER ON DOCK OF FIFTY-EIGHTH STREET POWER PLANT OF THE INTERBOROUGH RAPID TRANSIT COMPANY.

The system consists briefly of a hoisting tower, weighing scales, a crusher located on the dock, conveyers to transfer coal from the hoisting tower to the power-house, conveyers to lift the coal to the bunkers, and conveyers to distribute the coal over the bunkers.

The boom of the tower is housed in a simple manner by sliding back, the suspenders which hold up the boom acting as the radii for the boom to swing upon.



BELT IDLER FOR ROBINS CONVEYING BELT SYSTEM.

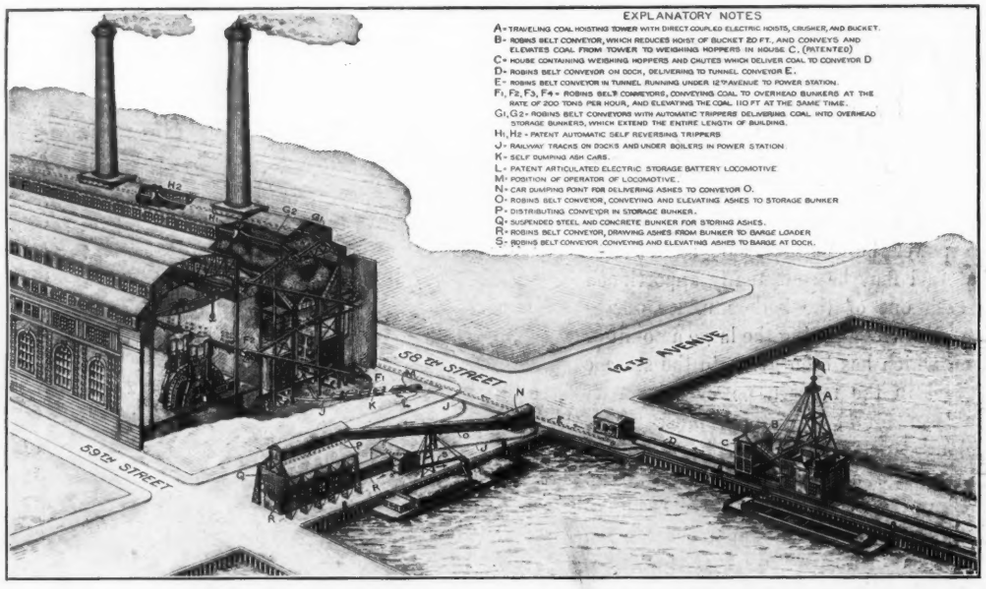


AUTOMATIC TRIP, ROBINS CONVEYING BELT SYSTEM.

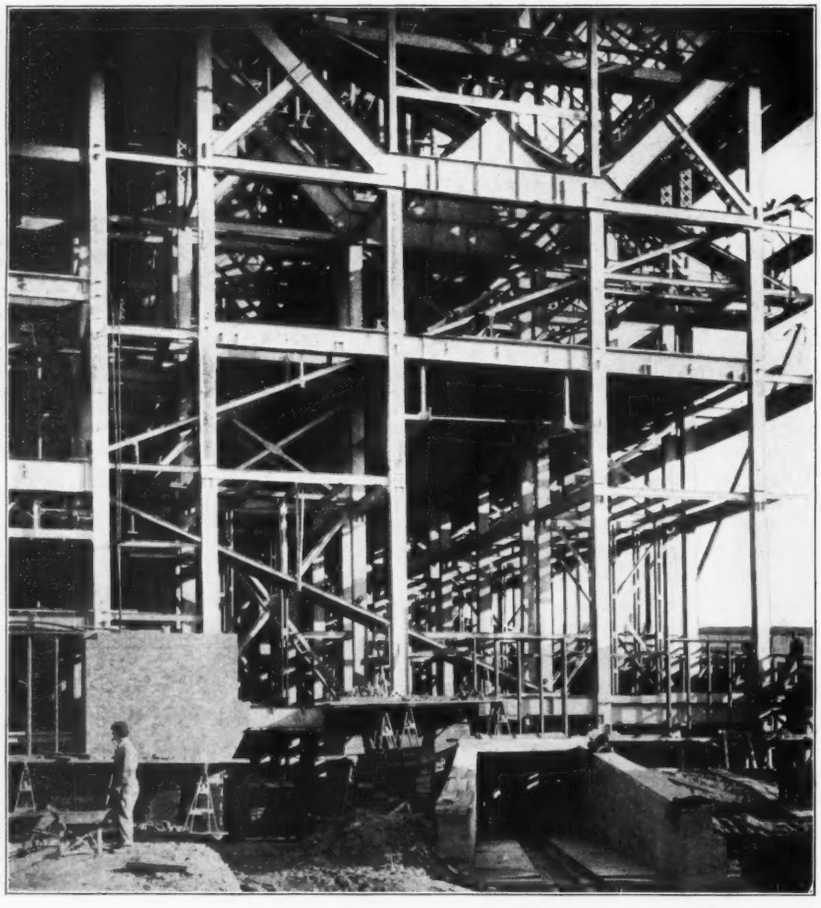
There is also a system of storage-battery locomotives and steel cars, and conveyers and bunkers to handle the ashes, which

may be delivered into scows or carts, as desired.

Two hoisting towers will ultimately be furnished to this system. The present one consists of a massive steel structure supported on wheels running on rails laid on the dock. Coal is hoisted from the barges in a one-ton clam-shell bucket operated by electric hoisting drums, power being supplied from the nearby power-house. After the coal is hoisted and dropped into the hopper of the hoisting tower it is delivered to crushers, which break it up to the necessary size and deliver it to a conveying belt connecting the scale house to the main hoisting tower. This belt elevates and discharges the coal into the scale hoppers. After the coal is automatically weighed it is delivered on to a belt running on the dock which discharges to one running under the street in a concrete tunnel, delivering at a point near the end of the power-house to a series of inclined conveyers of the Robins belt type, running back and forth, switch-back fashion, up to the inside face of the power-house. The upper conveyer delivers on to two longitudinal conveyers, running lengthwise over the top of the coal-bunker. These conveyers, supported on the trusses over the bunkers, discharge automatically by means of a Robins automatic reversible tripper, thereby filling the bunker for its entire length, or delivering to any given point, as may be desired. These trippers are very ingenious and are absolutely automatic. They work backward and forward, their power being derived from the main conveyer belt. By simply placing a stop on the rail the tripper stops, reverses automatically and goes in the opposite direction, delivering coal as it moves. When this tripper reaches the other end of the predetermined travel, where another stop has been placed, it again reverses and the operation is continued as before.


EXPLANATORY NOTES
A- TRAVELING COAL HOISTING TOWER WITH DIRECT COUPLED ELECTRIC HOISTS, CRUSHER, AND BUCKET.
B- ROBINS BELT CONVEYOR, WHICH REDUCES HOIST OF BUCKET 20 FT., AND CONVEYS AND ELEVATES COAL FROM TOWER TO WEIGHING HOPPERS IN HOUSE C. (PATENTED)
C- HOUSE CONTAINING WEIGHING HOPPERS AND CHUTES WHICH DELIVER COAL TO CONVEYOR D
D- ROBINS BELT CONVEYOR ON DOCK, DELIVERING TO TUNNEL CONVEYOR E.
E- ROBINS BELT CONVEYOR IN TUNNEL RUNNING UNDER 12TH AVENUE TO POWER STATION.
F1, F2, F3, F4- ROBINS BELT CONVEYORS, CONVEYING COAL TO OVERHEAD BUNKERS AT THE RATE OF 200 TONS PER HOUR, AND ELEVATING THE COAL 110 FT AT THE SAME TIME.
G1, G2- ROBINS BELT CONVEYORS WITH AUTOMATIC TRIPPERS DELIVERING COAL INTO OVERHEAD STORAGE BUNKERS, WHICH EXTEND THE ENTIRE LENGTH OF BUILDING.
H1, H2- PATENT AUTOMATIC SELF REVERSING TRIPPERS
J- RAILWAY TRACKS ON DOCKS AND UNDER BOILERS IN POWER STATION
K- SELF DUMPING ASH CARS.
L- PATENT ARTICULATED ELECTRIC STORAGE BATTERY LOCOMOTIVE
M- POSITION OF OPERATOR OF LOCOMOTIVE.
N- CAR DUMPING POINT FOR DELIVERING ASHES TO CONVEYOR O.
O- ROBINS BELT CONVEYOR, CONVEYING AND ELEVATING ASHES TO STORAGE BUNKER
P- DISTRIBUTING CONVEYOR IN STORAGE BUNKER.
Q- SUSPENDED STEEL AND CONCRETE BUNKER FOR STORING ASHES.
R- ROBINS BELT CONVEYOR, DRAWING ASHES FROM BUNKER TO BARGE LOADER
S- ROBINS BELT CONVEYOR CONVEYING AND ELEVATING ASHES TO BARGE AT DOCK.
59TH STREET
12TH AVENUE
59TH STREET

SCHEMATIC DIAGRAM OF COAL AND ASH-HANDLING PLANT, INTERBOROUGH RAPID TRANSIT COMPANY.



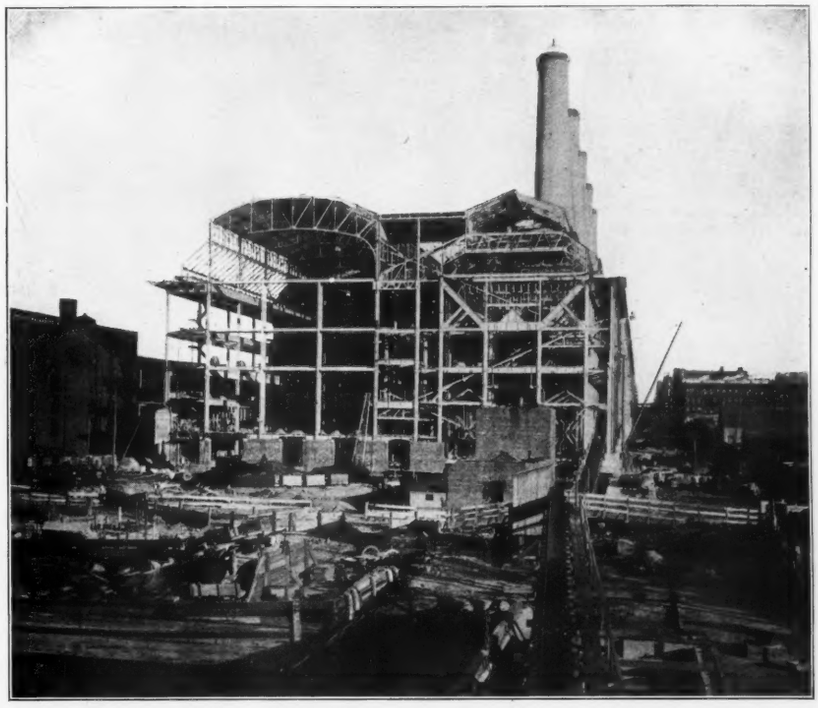
SECTION OF POWER-HOUSE, SHOWING CONTOUR OF CONVEYOR BELT SYSTEM FOR COAL-HANDLING PLANT, AND VAULT AT THE RIGHT FOR ASH-HANDLING SYSTEM, INTERBOROUGH RAPID TRANSIT COMPANY.

The principle of putting the scale house to one side, it being rigidly connected with the tower by structural steel, is unique and by doing this the total hoist of the tower is very much reduced, thereby saving many hours during the day's run.

All the conveyers referred to are thirty-inch, and have a capacity of about 300 to 500 tons an hour. They will not be called upon to carry quite as much as this at present, but when the two towers are installed there will be times when the capacity of these conveyers will greatly exceed this figure.

The ash-handling system consists of a

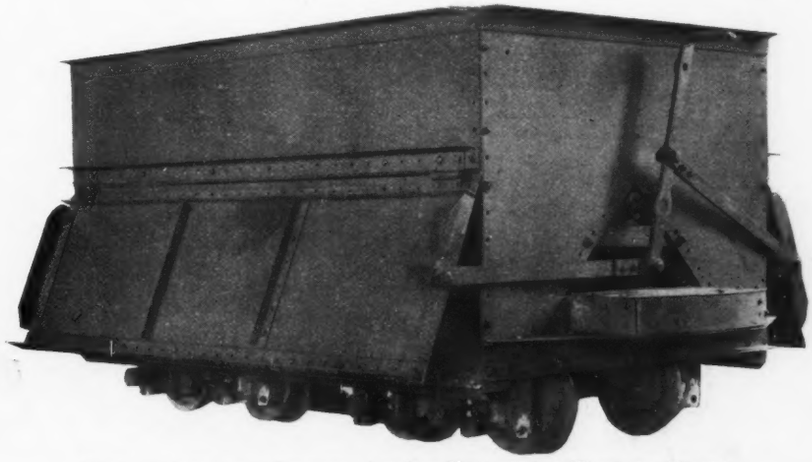
number of steel cars and a storage-battery locomotive. The cars are of the usual double side-dump pattern, and the storage-battery locomotive used is of the Robins articulated type, consisting primarily of two separate units connected in such a way that they may traverse as short a radius curve as the small steel cars.



POWER-HOUSE, BEFORE HOUSING IN, SHOWING CONTOUR OF BELT CONVEYER SYSTEM FOR COAL-HANDLING PLANT.

The batteries are mounted in such a manner that there is no chance for leakage either of current or liquid, and are supported in an entirely new way on rubber balls, and the locomotive, instead of being driven as is usually the case by gears, is driven by a Morse silent chain, which allows a very flexible connection.

One operator can handle the complete string of cars, and run the machine in either direction without changing his position. This system of cars receives the ashes from under the boilers, and when they are quenched, hauls them to a track-hopper. At this point the ashes are dumped on to a Robins belt conveyer, which elevates them into a 1,000-ton Berquist-type ash-pocket, which in turn can deliver the ashes to either scows or carts, as may be desired. There is also a supplementary conveyer which will receive the ashes direct and put them in scows without the necessity of having them go through the ash-pocket.



TYPE OF AUTOMATIC DUMPING ASH-CAR USED IN ASH-HANDLING PLANT, INTERBOROUGH RAPID TRANSIT COMPANY.

This whole equipment is motor-driven, and all of the coal-conveying systems of this immense plant can be taken care of by one man, the ash-handling by one man, and the hoisting and weighing by three men.

The accompanying illustrations, with explanatory notes, will be of assistance to the reader in understanding the general layout of the above plant. In one of these illustrations the end wall of the power-house is removed, so as to show the inclined conveyers and the conveyers over the boilers more clearly. The entire system was designed and installed by the Robins Conveying Belt Company, New York city.

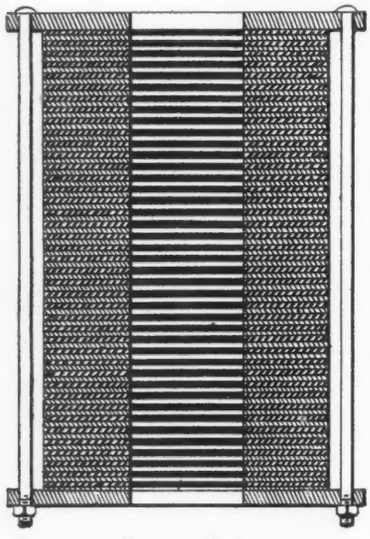
Instantaneous Photographs by Electric Light.

A French photographer, M. G. A. Liebert, has recently devised an apparatus which will enable him to take instantaneous photographs in his studio. This device is described in *La Revue Patrique de l'Electricité* for December 5. The object of using electric lights is to give the photographer entire control of the quality and amount of illumination and to render him independent of daylight. Moreover, to obtain the best portraits it is very desirable that they should be taken instantaneously and at the moment when the subject is in the best pose.

The device consists of a large parabolic reflector of aluminum, having placed on its inner edge a series of incandescent lamps shaded with ground-glass screens. The object of these is merely to light up the subject, permitting the photographer to secure the best pose and to determine when the real exposure should be made. At the centre of this reflector is an arc lamp with three carbons. One of these is fixed, and the other two are movable. When a photograph is to be taken, the subject is arranged and the sensitive plate is exposed. The photographer then waits until a desirable pose has been secured, when he presses a rubber bulb, which draws the two movable arc light carbons across the fixed one, thus forming a brilliant arc; but the moment the current passes through the lamp the movable carbons are drawn away from the fixed one by means of an electromagnet, and the arc is thus extinguished. It lasts about one-fiftieth of a second, but this gives sufficient time for an exposure.

Electrical Patents.

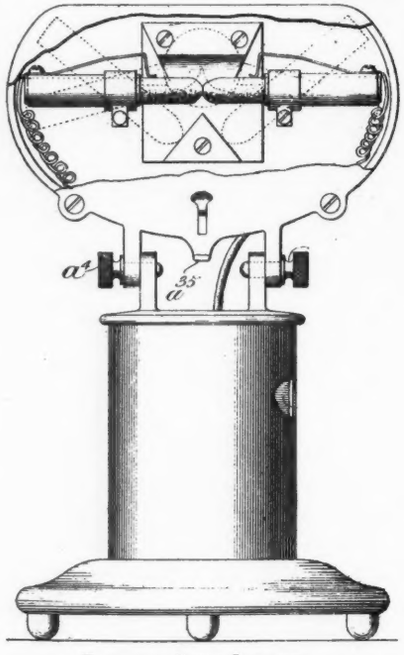
The Keystone Electric and Manufacturing Company, of Pittsburg, Pa., is the assignee of a patent (777,148, December 13) recently granted to Albert Schweitzer, of the same place, on an improved magnet coil. The invention relates to improvements in electromagnet coils, such as solenoids, etc. The object is to provide a coil for these purposes which occupies a smaller space than coils as ordinarily wound, and which, nevertheless, has a larger current-carrying capacity and produces less heat and offers less resistance proportionately. Another object is to produce a coil which can be insulated in such a manner as to prevent the same being burned out or short-circuited, and which is simple, durable and strong. The invention consists of a coil having a spiral conductor composed of a flat strip wound edgewise to form a plurality of convolutions, the flat faces of which lie in sub-



Magnet Coil.

stantially parallel planes and are separated by discs of mica or other suitable insulating material slit in from one edge to the centre and arranged between the several convolutions of the coil.

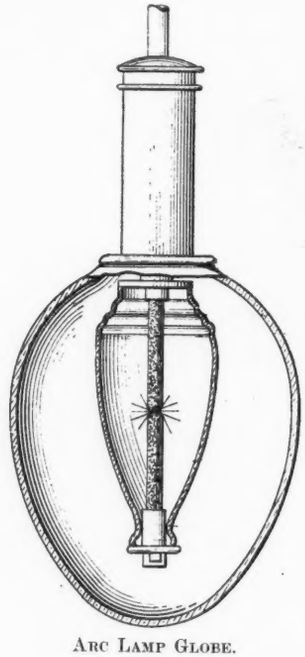
A cigar-lighter has been devised and patented (777,061, December 13) by James I. Ayer, of Cambridge, Mass., and has been assigned to the Simplex Electric Heating Company, of Boston, Mass. The invention is an electrical device for producing intense heat, the mechanism of which is also adaptable for various other purposes where intense heat is desirable at intervals. In carrying out the invention means are employed for automatically focusing an arc light at the point desired, together with an automatic adjustment of the carbons and automatic return to open circuit when out of use. In connection with certain uses of the apparatus a shutter or screen is provided which permits the presence of the operator close to the arc or furnace without danger of injury. One object of the invention is to provide a practical lighting or heating



Electric Cigar-Lighter.

device in the form of an electric arc capable of safe and convenient use by the unskilled, and for this purpose the mechanism is entirely self-adjusting and operable by the simple depression of a lever without requiring any knowledge of electricity or of the construction of the device, and without any danger to the user, or ability of the mechanism breaking down or burning out, but ready at all times to be instantly and automatically lighted and extinguished. In the embodiment of the invention, a pair of tubular holders are employed having electrodes loosely mounted therein. Means are provided for engaging the ends of these electrodes and holding them separated when out of use, this means automatically adjusting the electrodes at a predetermined distance from each other. Other means are provided for moving the electrodes into mutual self-adjusting contact for establishing the circuit. Means are also provided for yieldingly holding the electrodes in their self-adjusted positions, and means for separating the electrodes for establishing an arc.

Solon O. Richardson, Jr., of Toledo, Ohio, is the inventor of an improvement (777,142, December 13) in globes, relating especially to improvements in inner globes which are used in electric arc lamps. The object of the invention is to provide an inner globe which shall be so constructed that it will not sag under the combined influence of the excessive heat and the weight which rests upon the top of such a globe. The embodiment of the invention comprises a globe having a support. A plug rests upon and is carried by the globe, the globe having a plain substantially cylindrical rim or top upon which the plug rests. A swelled portion extending from the lower edge of the top forms the shoulder. The body portion tapers downwardly from the shoulder to



Arc Lamp Globe.

a narrow neck, this body portion being smooth and plain and the shoulder being corrugated to provide an increased radiating surface.

The Telephone in New Zealand.

According to the report of the postmaster-general of New Zealand, the telephone system of that country is being extended as follows: in 1903 there were 1,161 kilometres of telephone lines, consisting of 15,823 kilometres of wire. In Wellington there were 2,103 subscribers; in Auckland, 1,707; in Dunedin, 1,579; in Christchurch, 1,479; in Wanganui, 425; in Napier, 334; in Invercargill, 335, and in New Plymouth, 320. In addition there were four other places with between 200 and 300 subscribers. There were nine places with between 100 and 200; six with between 50 and 100, and fifty-three with less than fifty subscribers. Up to April, 1904, £1,053,692 was paid by the treasury for the construction of telephone and telegraph lines.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.

DISCUSSION OF THE MAXIMUM DISTANCE TO WHICH POWER CAN BE ECONOMICALLY TRANSMITTED.

The 192d meeting of the American Institute of Electrical Engineers was held at Carnegie Hall, New York city, Friday evening, December 23, 1904. President J. W. Lieb, Jr., was in the chair.

The paper to be considered was by Mr. Ralph D. Mershon, New York city, and was entitled "The Maximum Distance to Which Power Can Be Economically Transmitted." This paper will be found on another page of this issue. In it Mr. Mershon takes up the general conditions limiting long-distance transmission, and shows that the limit depends finally upon the cost of the conductors, and upon this alone. He then makes certain assumptions, and upon these proceeds to find what the limits are. The power considered, the distance of transmission and the voltages used are much greater than anything found at present, but the paper is intended rather as a glance into the future than as a consideration of present practice. The most interesting result of this investigation is that, under the conditions assumed, the limiting distance of transmission will be fixed, not by atmospheric losses, but by economical considerations. This distance was found to be in the neighborhood of 550 miles.

During the reading of the paper Mr. Mershon called attention to a slight error in Fig. 4. The power curve for 500,000 kilowatts should come down to fourteen per cent at 700 miles. This will raise the curve in Fig. 5 to about 400,000 kilowatts at the same distance.

The discussion was opened by President Lieb, who dwelt upon the importance which the electrical transmission of power from waterfalls is assuming. All sections are actively interested in this country, particularly the West and the South. In Europe, Switzerland and Italy are well to the front in transmission development.

Mr. H. G. Stott, New York city, spoke of the interest which this paper would have to capital in its relation to the electrification of steam railroads. He took up the question of reliability, and held that in a large system, if the interruptions during the year exceed one hour, the reliability is not satisfactory. He touched upon the possibility of transmitting power from Niagara to New York, as this would come within the limit found by Mr. Mershon. He, however, differed from Mr. Mershon in the method of charging for power, as he did not believe it just to the consumer to make a flat annual charge per kilowatt. Assuming Mr. Mershon's selling price of $34 per kilowatt-year, and a load-factor of fifty per cent, he found that the price per kilowatt-hour would be about eleven cents, which would be prohibitive in competition with a steam plant. On the other hand, he did not know of any place where a horse-power could be delivered at the switchboard for $10.90 a year. He did not believe in the use of synchronous motors on transmission lines, and he thought that the paper was too optimistic in the voltage considered.

Mr. Philip Torchio, New York city, dwelt upon the application of Kelvin's law in determining the economical distance of transmission. He thought that, in this treatment, sufficient allowance has not been made for decreased cost of the apparatus for a small increase in the plant. He dwelt upon the necessity of considering the maximum energy drop, which should not be more than ten per cent when operating rotary converters, fifteen per cent for driving synchronous motors, and twenty per cent for induction motors. He thought the price of power for many years to come would be set by the cost of coal, and he gave figures showing the small part of the total coal consumption used in generating electric power. The consumption of coal in this country is about 1,000,000 tons per day, and of this, only three per cent goes for producing electrical energy. This is insignificant compared with the whole, so that cheapening electrical power will have little effect upon the average price of power. Mr. Torchio thinks that the greatest progress in the cheapening of power will be brought about by the development of a successful rotary gas engine. He thinks that $34 per kilowatt-year at the receiving end is excessive, and from figures given in the United States census reports, he deduced a price of $22.72 as the average yearly cost of power in this country. Should long-distance transmission, as considered by Mr. Mershon, come into use, it would be necessary to have a large steam reserve to ensure reliability. The systems then should be operated together, the steam plant carrying the peak and the transmission system furnishing the steady load.

Mr. C. F. Wallace, Boston, Mass., said that transmission engineers had set 60,000 volts as the limit, for the present at least, and that this figure has been decided upon, not as an economic pressure, but on account of reliability. He did not think that the slight gain obtained by raising the voltage was sufficient compensation for the greater liability to breakdowns incurred. He said that it was not proper to apply Kelvin's law as had been done, and he believes that this law, as usually stated, is based upon an error.

Mr. C. H. Parmly, of New York city, taking up the last point made by Mr. Wallace, showed that, if Kelvin's law be applied under the conditions assumed in the paper, it might lead to an absurdity. The law, as usually applied, considers the distance of transmission as the only variable; but this is incorrect as there are three variables.

Mr. M. H. Gerry, Jr., of Helena, Mont., doubted the utility of mathematical investigations into such problems as presented in the paper. These always involved many assumptions based upon engineering knowledge, and, in any case, the accuracy of the results depended upon the experience of the analyzer. By changing Mr. Mershon's assumptions, it is possible to make the limit of transmission anything between 200 and 2,000 miles; hence any attempts to find one solution of the general problem could be of little practical value.

Dr. A. E. Kennelly, of Boston, Mass., sketched briefly the historical development of electrical transmission, and showed how the limits set at different times by engineers had been extended and reextended. Our experience should, therefore, teach us that it is risky to try to determine the limits of future transmission by the conditions obtaining to-day. The paper of the evening was a study of certain assumptions, and the results obtained seemed to him to be of considerable interest.

Mr. C. F. Scott, Pittsburg, Pa., said that he had learned the risk involved in making prophecies, from personal experience. It was not wise to prophesy too far ahead. The paper seemed to him to be of much value, as it is an examination of certain conditions, and these are based upon the wide experience of the author.

Mr. C. L. de Muralt, New York city, said that in Switzerland, which is the transmission country *par excellence,* power is sold at $20 per horse-power-year, or $30 per kilowatt-year. There, however, coal costs about three times as much as it does here, and hence he did not think there was much chance for successful long-distance transmission in this country in competition with steam.

Mr. P. G. Gossler, of Montreal, Quebec, objected to the figure of $22.72 as the cost of a kilowatt-hour, which has been

given by Mr. Torchio. The latter pointed out that this figure did not include many items of cost which entered into the delivery price of power. These were administrative costs, maintenance, etc.

Mr. Mershon, in reply to the criticisms of his paper, said that of course it was only an examination of certain assumptions, but he believed that these assumptions were fair, and that the results reached had real value. He thought that it is justifiable to charge a flat rate for power from water-power plants. He pointed out that, in his paper, a concentrated load at the end of the line had been considered, but, in practice, the load would probably be distributed along the line. This condition should be remembered. In regard to criticisms of Kelvin's law, he did not think it was incumbent upon him to prove its correctness.

AN ELECTRICALLY OPERATED HIGHWAY DRAWBRIDGE FOR SMALL WATERWAYS.

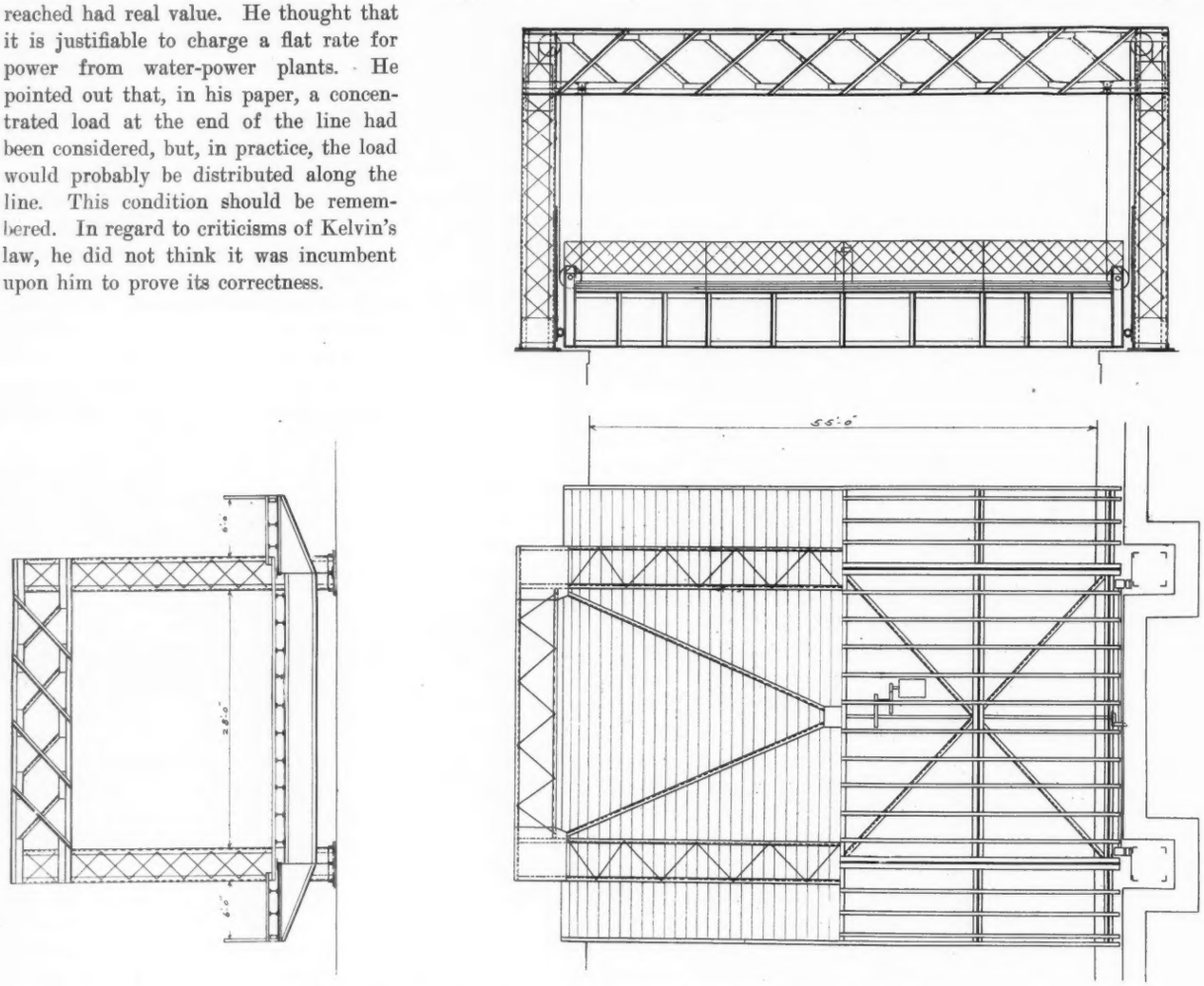
BY H. G. TYRRELL.

The accompanying plan shows an economical form of electrically operated drawbridge for small waterways. It was prepared by the writer as a competitive design for a crossing of the Miami & Erie canal at New Bremen, Ohio, but can be used for any similar location with slight modifications.

The canal is used for barges only, and the required clear head-room is twelve feet. As will be seen from the plan, the bridge has a clear roadway of twenty-eight feet, and two six-foot sidewalks. It has plank floor and steel joists. It consists of an ordinary deck-plate, girder, highway bridge, suspended and counterbalanced by means of wire ropes, passing up and over sheaves at the top of the four corners. The counterweights move up and down inside the towers. By using two strands of rope instead of one the amount of the counterweight is reduced by half. The fixed end of the counterweight rope is attached to the upper overhead lattice girder, and produces bending therein. The bridge is raised and lowered by means of four pinions working on racks attached to the corner towers. These pinions are connected through a series of shafts and gears to a ten-horse-power electric motor placed beneath the bridge floor. The motor and machinery directly attached thereto are encased in a wooden box to protect it from the weather. For oiling or inspection, it can be reached by a movable panel or trap door in the bridge floor. The controller is placed against the bridge railing and is likewise enclosed in a wooden box. The electric current is taken from the street wires. The estimated quantities of material in the bridge superstructure are as follows:

Riveted steelwork, thirty-seven tons.

Machinery, five tons.



SECTION, PLAN AND ELEVATION OF ELECTRICALLY OPERATED LIFT BRIDGE.

Long Life of a Railway Motor.

A motor on the Sandwich, Windsor & Amherstbury Railway, Windsor, Ontario, has been in operation for about eight years and has covered about 450,000 miles. Aside from the replacing of brushes, turning up of commutator, and rebabbitting of bearings, nothing has been spent on it for repairs. The only wear is on the commutator, which has been turned off three-eighths of an inch. The wearing depth of the segments was originally three-quarters of an inch, so that if the winding holds out, the motor should last for eight years more.

Counterweight iron, twenty tons.

Steel joist, six tons.

Wire rope, 200 lineal feet.

Ten-horse-power electric motor and equipment.

Lumber, 6,000 feet.

The estimated cost is $5,300. Before deciding on this form of bridge, a careful study was made of various other forms of movable bridges. Generally speaking all forms of lift bridges require expensive counterweights. In this case the cost of the counterweights alone is about twenty per cent of the entire cost of the superstructure. In nearly all other forms of lift bridges, the cost of counterweight greatly exceeds this amount. In the case of the South Halstead street lift bridge at Chicago the total weight of metal in the structure is 675 tons, and of this amount 290 tons or forty-three per cent is counterweight. This expensive feature applies not only to direct lift bridges, but also to all forms of bascule bridges, which are counterweighted to a greater or less extent.

In the case also of swing bridges over a canal where only one waterway occurs, it is necessary either to build one-half of the bridge over the land, where it is not required, excepting for a counterbalance, or to use a bob-tail draw with sand or cast-iron counterweight, either of which arrangements is expensive.

The retractible form of draw, similar to the new Summer street bridge in Boston, which rolls back on a track at an angle of forty-five degrees to the canal, is likewise expensive, inasmuch as a large part of the bridge must be built over the land in order to give room for mounting it on trucks. The trucks and track and the excavated recess for the bridge when it is rolled back into its open position, all add to the cost.

The ordinary type of drawbridge, such as is commonly used on this and other canals for small roadways, will not apply for wide roadways with sidewalks. The ordinary drawbridge in rural districts on the Miami & Erie canal has a roadway of from twelve to sixteen feet, and is a bob-tail swing. The normal width of the canal is fifty feet, so as to allow three boats, each fifteen feet wide, to pass each other. But at crossings the canal is frequently narrowed to about thirty-two feet, and the cost of the drawbridge reduced accordingly. This type of draw is opened by the pressure of the boat on the side of the bridge, and after the barge has passed the bridge comes back automatically into its closed position. A bumping timber backed with springs is bolted to the side of the bridge to receive the blow of the barge as it strikes the bridge and opens it. These bridges are very common along the canal, and are satisfactory for rural districts and light travel. But where wide roadways and sidewalks are required, to accommodate city travel, this light bridge is no longer practicable.

The estimated cost of some other forms of bridges for this same location is as follows, in each case the estimate is based on providing a fifty-foot clear waterway.

A double leaf bascule, with leaves meeting in the centre of the canal, and towers on both sides, with a platform sixty feet long, would cost $5,700.

A single, retractible draw, similar to the new Summer street bridge in Boston, would cost $7,300. In this case the length of platform required is seventy-five feet on one side and 115 feet on the other.

A bob-tail swinging plate girder draw, with sand counterweight, would cost $5,400. The length of platform in this case is ninety feet.

A revolving truss draw span with arms of equal length, and a platform of 140 feet, would cost $6,700.

Comparative estimates are, therefore, as follows:

Tower lift bridge, $5,200.

Double-leaf bascule, $5,700.

Single retractible draw, $7,300.

Bob-tail plate girder swing, $5,400.

Revolving truss span, equal arms, $6,700.

The bridge can be opened by electric power in one minute, and it appears to fill all the requirements of the location.

A set of ordinary crossing gates is necessary, one at each end of the bridge, which are lowered when the bridge is open.

Progress in the Manufacture of Artificial Carbons.

At a recent meeting of the German Chemical Society a paper was read by J. Zellner, describing the progress which has taken place in the manufacture of artificial carbons. This industry has developed during recent years on account of the growth of the electrolytic industries. Artificial carbon was formerly manufactured from bone-black, but as this was not sufficiently abundant, wood charcoal was substituted, and anthracite coal later took the place of the wood. In the manufacture of carbons for primary batteries, the principal modification which has taken place has been the substitution of hydraulic pressure for agglomerating the mixture of graphite and manganese dioxide, instead of baking. The older process caused a partial reduction of the manganese dioxide. Carbon dynamo brushes now contain about one-third of copper dust, one-third carbon, and one-third pitch. The attempt to reduce the resistance of the brush by the addition of copper is not entirely satisfactory, because the unequal coefficients of expansion of copper and carbon make it impossible to maintain a constant and close contact between the two. Among the carbons for arc lamps, the Bremer carbons have been improved considerably, and the lamps are now coming into use. These carbons contain alkaline fluorides and alkaline earths, with the addition of borates and silicates. Formerly the salts were added to the carbon by plunging the carbon rod in a saline solution. This gave poor results. At present the powdered material is mixed with five per cent of the fluoride, then pressed into shape and baked. Three qualities of carbon are manufactured—those giving a yellow light, which contain calcium fluoride; those giving a red light, which contain strontium fluoride; and those in which the light is white with green reflections. These contain barium fluoride. Wedding has shown that the yellow flame gives the clearest illumination and is most advantageous. He found that, with an increasing proportion of the salts of from eight to forty per cent, the amount of light given out increased, while the consumption of energy decreased. Attempts to improve the regulation of flaming arcs have been made by placing the salts in a core of the carbon and by adding to them from ten to fifteen per cent of potassium silicate. The carbons can be made to give almost any color. A mixture containing calcium and magnesium fluoride gives a long, reddish arc which is very clear and stable. Other materials have been added to the carbon, such as infusible earths, nitrates of thorium, zirconium, and oxides of titanium, vanadium, etc., with encouraging results. Attempts to construct carbons containing calcium carbide have been unsatisfactory, because of the effect of moisture. When these enriching substances do not dissociate easily, they act simply to color the flame; but when dissociation takes place, the increase in the conductivity of the arc increases its length. The fluorides act in the latter way and give the best results.—*La Revue Pratique l'Electricité (Paris), December 5.*

Reviews of Current Engineering and Scientific Literature.

Graphical Determination of the Characteristics of the Compound Dynamo.

In this article M. C. E. Guilbert discusses briefly the magnetic conditions which occur in the compound dynamo, and gives a graphical method of determining the voltage of the compound machine under load, from the no-load characteristics and the load characteristic of the dynamo run as a shunt machine. Taking the no-load characteristic, and drawing the field resistance of the line, this intersects the characteristic at the no-load voltage. If, from this point, a horizontal line be drawn, equal in length to the ampere-turns of the series coil, and from the end of this line another line be drawn parallel to the resistance line, the point of intersection of this third line with the load characteristic will give the terminal voltage of the compound machine under load. This applies to machines wound for over or under-compounding, and by a similar construction the number of series ampere-turns required to give any voltage required, under any load, will be found easily. —*Translated and abstracted from L'Éclairage Électrique (Paris), November* 26.

Comparative Designs for a Ten-Kilowatt Dynamo.

In this article Mr. J. W. Burleigh compares five designs of dynamos for ten kilowatts. The first type is the Manchester; the second, the horseshoe; the third, the ordinary four-pole; the fourth, a modified ironclad type, and the fifth, the so-called zone type. In the latter the armature is encircled by a single magnetizing coil. There are four pole-pieces, though, in effect, only two poles. The design causes a somewhat unusual distribution of the magnetic flux. In all types the same armature is used, except in the four-pole machine, where the winding was necessarily a little different, calling for an extra slot. The Manchester type is well adapted for an open-type dynamo or motor, but is not suitable for the enclosed type. The same remark applies to the horseshoe type. The cost of the material in these two is practically the same, though the horseshoe type is a little better than the Manchester, due to a lack of joints. On the other hand, the Manchester type is better from a commutating standpoint. The last three types are all suitable for open or enclosed machines. The four-pole type will be comparatively expensive in labor cost, though costing less for material than the ironclad type. It is thought that the latter would, on the whole, be cheaper than the four-pole type. The zone type is very compact, requires little material, and is thought to be the cheapest construction on the market. Due to the distribution of flux, the commutating is excellent under all loads. From a table of costs it is seen that the material for the ironclad type costs the most. Next comes the horseshoe, followed closely by the four-pole type. The material for the zone type costs only two-thirds as much as that of the cheapest of the other four.—*Abstracted from the Electrical Review (London), December* 9.

A New Type of Oil Fuse.

Exhaustive tests were recently carried out at the works of the Lahmeier Company, Frankfort a. M., Germany, with a view to determining a suitable type of high-voltage fuse. The first attempts were made with a fuse submerged in oil, which gave satisfactory results up to tensions of 10,000 volts; but the explosion caused by the melting of the fuse was considerable and tended to scatter the oil. A satisfactory fuse of this type requires such a large volume of oil as to make it commercially impracticable. It was also found that the cooling effect of the oil on the fuse made the latter unreliable. It was, therefore, decided to try a device in which the fuse proper was not submerged in oil, but in which oil was used to extinguish the arc after it had been formed. The device consists of a glass cylinder with terminals at the top and bottom. The fuse proper is placed within an inverted cup of insulating material. This cup is closed at the top and open below, and is placed partially submerged in the oil, though the latter can not come in contact with the fuse. Contact is made with the fuse by a clamp at the top, with two flexible copper wires attached to its lower extremity, and passing down to the socket at the bottom of the glass tube. There is also a spiral spring attached to the lower end of the fuse. When the fuse is melted, the spring draws it down under the oil. At the same time, the vapors are forced out at the bottom of the cup through the oil. This cools them and extinguishes the arc. This construction is found to give satisfactory results. A circuit may be fused so that it will carry its normal load indefinitely. It will carry continuously an intermittent overload of fifty per cent. It will carry an overload of eighty per cent for five minutes, and melt in less than two minutes if the load be doubled. Some curves are given, showing the relation between the diameter of the fuse wires, the current which will fuse it, and the time.—*Translated and abstracted from L'Électricien (Paris), December* 10.

Electric Power Distribution in South Wales.

The South Wales Electric Power Distribution Company is now in active operation, and is supplying power to a large number of collieries and other works in the South Wales industrial district. The connections amount to about 9,000 horsepower. By far the greater part of this load is for actual power supply. The company's district covers an area of 1,034 square miles, but within this district are several towns which have municipal plants, and for this reason exclude the system of the South Wales company. The district may be divided into four parts, each supplying from its own generating station. The largest of these is the Treforest, where current is generated at 11,000 volts, three-phase, twenty-five cycles per second. At Cwmbran the same pressure and frequency have been adopted for the longer feeders, but 2,200 volts has been deemed sufficient for the works near the station. At Bridgend the pressure is 3,000 volts, two-phase, sixty cycles, and at Neath it is 2,200 volts, two-phase, fifty cycles. The high frequency of the latter stations was adopted partly because of the supply of alternating current for lighting to the local authorities, and partly because the Bridgend station had to be started as early as possible, and the sixty-cycle machinery was available from the start. The company purposes using high voltages—possibly 30,000—for the long transmissions. The output of the Treforest station is at present only 5,000 kilovolt-amperes, but provision has been made for increasing this by 150 per cent. In this station all the boiler-house auxiliaries are electrically driven. The generating station contains two three-phase Willans-Ganz alternators, direct-connected to Willans and Robinson engines. These are the largest engines the latter company has ever built. The alter-

nators generate current at 11,200 to 12,000 volts on each phase, and are star-wound. The neutral point is not earthed. This plant has been provided with a device for charging the mains before they are connected to the generators. The distributing cables are three-core, lead-covered cables, armored with galvanized steel wires. The insulating material is a fine manila paper, thoroughly impregnated with bitumen and fine oil. The cores, after being twisted together, are passed through a wax and bitumen compound, and then covered with a lead sheath. They are tested at 20,000 volts, and this test is repeated after laying and jointing. The cables are laid on the solid system in earthenware ducts, and are supported in these ducts by wooden bridges At the Cwmbran station there are only two 300-kilowatt units, but larger units will be installed shortly. The substations at present are nearly all fitted with stationary transformers. One exception is that of a large iron and steel works, where continuous current is preferred. Here a motor-generator has been erected. At the Wellman furnace an electric charger for charging open-hearth furnaces is operated by means of four series motors, each having its own controller. But a few seconds are occupied in charging the furnace, the only hand labor required being the manipulation of the controllers on the cab of the discharger and the opening of the furnace door. The largest motor on the South Wales company's mains is a 400-horse-power induction motor running on a 2,000-volt, twenty-five-cycle, three-phase supply from the Cwmbran station. This motor drives two sets of rolls at a wire-drawing mill. The greatest part of the output of the system is taken up in the "main and tail" haulage gear at various collieries. These motors are geared so as to give two speeds, either of which can be thrown in without stopping the motor. The speeds are eight and five miles an hour. These equipments are usually driven by three-phase, variable speed motors rated at from 200 to 300 horse-power, 440 volts, twenty-five cycles. When the district has been a little more developed, it is intended that all the power-houses shall be operated in parallel.—*Abstracted from the Electrician (London), December 2 and 9.*

An Electric Truck Test.

The electric truck for the delivery of merchandise has been in extensive use in and around the larger cities for a number of years, and with a view to ascertaining the exact working conditions, a test was made on three electric trucks of standard manufacture, and used by a firm in Manhattan and Brooklyn. The test, which is here described by Mr. W. S. Timmis, extended over a period of four months, and the results represent actual conditions as found in ordinary practice. The trucks were run every working day when they were in condition. The result of the test of one truck—which is a representative average of the three—is given. The trucks were in use between Manhattan and Brooklyn, delivering merchandise from Brooklyn to Manhattan, and were subjected to rather hard usage, incident to crossing ferries and running on bad streets in Brooklyn. The record of each test run was made up on a card, on which was noted the hour of departure, the time of each stop, and the time between stops. If there was any unusual delay in the trip, the cause was noted. The estimated mileage between each stop was also entered. At the head of the card the voltage at ten amperes, the weight and the number of cases or packages on the truck were entered, both at the time of departure and return. A summary of the test of one truck, and the average cost of running one of the three trucks for one year, are shown in the following table:

Duration of test, four months	120 days.
Number of working days during test	109 days.
Number of days truck was in operation	90 days.
Percentage of days in commission	88.6 %
Total miles run, going and coming	1,542 miles.
Average distance per day	17.13 miles.
Actual running time per day	3.766 hours.
Average miles per hour	4.53 miles.
Average miles per trip	10.28 miles.
Average trip per day	1.71
Total weight carried	323 tons.
Average net load when starting	3,915 lbs.
Average net load carried per day	7,183 lbs.
Cost to operate per mile, going and coming	49.5 cents.
Cost per ton-mile, estimating forty per cent mileage as returning empty	35.5 cents.
Cost to operate per day (effective service)	$8.33
Cost to operate per year	$2,300

Above cost itemized as follows:

Interest and depreciation	$200
Automan, $15 per week	780
Charging, 80 cents per day, 300 days	240
Tires	270
Motor repairs	20
Batteries, repairs and renewals	650
Running gears	140
	$2,300

Two-horse trucks can be obtained in the vicinity at the rate of $5.50 per day, and by the week of six days at $30 per week. The charging of the trucks was done on the owner's premises from its own plant. A direct-current, 230-volt, three-wire system was used in the building, and current was taken from the two outside wires for power at 230 volts, and from either outside wire and the neutral for lighting at 115 volts. The trucks are charged from the lighting circuit, and to avoid the danger of overloading one side of the line, a motor-generator balancing set, of sufficient capacity to take care of two trucks on either side of the line, was installed. A specially designed charging switchboard was built and erected, provided with four, two-pole, double-throw switches. Two of these were placed on one side of the neutral, and two on the other. Four trucks could be charged simultaneously, and the double-throw switches enabled them all, or a portion of them, to be charged, either at the shipping platforms or in the auto-house. The switchboard is provided with "I-T-E" overload and underload circuit-breakers. The charging was done at night, and consumed about four hours. The expensive parts of the electric truck are the batteries, tires and gears. The battery problem is of long standing, and its difficulties are not lessened by placing it on a moving vehicle, the vibration of which causes a breaking down of the elements. Various forms of wood and rubber separators and plate envelopes have been tried. The tire problem is receiving much attention, and dependable tires at a moderate price may be looked for. The gearing should undoubtedly be enclosed and made dust-proof. The cost to operate an electric truck per ton-mile was 35.5 cents. The cost per ton-mile on the Lake Shore & Michigan Southern Railway for the past ten years has been 5.25 mills, which clearly shows a large margin in favor of a smooth metal road and a dependable motive power. Under the conditions of load and character of delivery, it is thought that three two-horse trucks will be able to do the same amount of work as the three electric trucks, as shown in the result of these tests.—*Abstracted from the American Machinist (New York), December 22.*

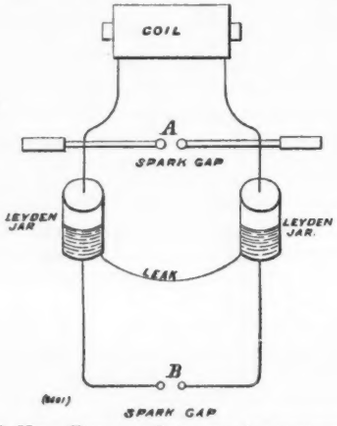
Annual Meeting of the Electrical Trades Association of Chicago.

The annual meeting and banquet of the Electrical Trades Association of Chicago, Ill., was held at the Grand Pacific Hotel, Chicago, Ill., on December 2. The attendance was larger than at any previous meeting. After the president's address, officers were elected for the ensuing year, as follows: president, E. R. Gilmore; vice-president, Seymour Guthrie; secretary and treasurer, F. P. Vose. Executive committee: Thomson I. Stacey, E. S. Kennedy and Frank Beardslee. James Wolff was elected as representative to the National association.

Electric Ignition in Motor Cars.

At a recent meeting of the Automobile and Cycle Engineers' Institute, of Great Britain, Sir Oliver Lodge read a paper entitled "Ignition as Applied to Internal Combustion Engines." He first explained the principles of this prime mover, and those governing the ignition of inflammable mixtures of air and gas or vapor. The existing types of apparatus were described briefly.

The most interesting part of this lecture is that in which the speaker described a new form of ignition apparatus, designed to avoid the difficulties met with in those now used. This device is illustrated in the accompanying diagram, which shows a coil that charges two Leyden jars. The outer coatings of these jars are connected together by a path of high resistance corresponding to a leak. This may be a piece of wet string or



A NEW FORM OF IGNITION APPARATUS.

other poor conductor. When the jars are fully charged, they spark across at the gap A, and, at the same time, a violent spark occurs at B. This latter spark completes the discharge of the jars, and if it be prevented from taking place, the spark at A becomes weak. The discharge is oscillatory and has a high frequency, but it does not obey the laws controlling ordinary currents. In character it is well suited for the ignition of internal combustion engines. The wires connected to B are at zero potential during the charge. There is no need that they should be insulated then, nor is insulation necessary during the short time of discharge, for the current will not leave the wire or avoid the spark-gap. This was illustrated by placing the gap B, under water, together with a portion of the bare wire. The spark is not diminished, and went on as usual until the tumbler containing the water broke. The spark-gap terminals were covered with a mixture of oil and lamp-black, and they were connected by a piece of arc-lamp carbon without in any way affecting the spark. The effect is due to the tendency of an oscillating current to keep to a straight conductor.

The American Association for the Advancement of Science and the American Physical Society.

The annual meetings of the American Association for the Advancement of Science and the American Physical Society are being held in Philadelphia, Pa., in "Convocation Week," from December 26, 1904, to January 2, 1905.

The presiding officers are Professors W. F. Magie, the vice-president of section B, and Professor Arthur G. Webster, president of the American Physical Society.

The opening session of section B was held on Wednesday after the adjournment of the general session, about 11 o'clock A. M., at which time the section organized, elected committees and listened to the reading of papers. The reading of papers was continued on Thursday. At 2.30 P. M., the retiring vice-president, Professor Edwin H. Hall, delivered the vice-presidential address, on "A Tentative Theory of Thermoelectric Action."

On Friday, December 30, the annual business meeting of the American Physical Society was held, and on this day the programme consisted of papers by members of this society.

The following papers of interest to electrical engineers were announced:

"Note on the Mirror-Telescope-Scale Method," by George F. Stradling, Philadelphia High School.

"Velocity of Sound in Gases at the Temperature of Liquid Air—Preliminary Note," by Samuel R. Cook, Cornell University.

"Some Convenient Laboratory Apparatus," by Horace C. Richards, University of Pennsylvania.

"Experimental Study of the Use of Weston Instruments for Ballistic Magnetic Testing," by Albert F. Ganz, Stevens Institute of Technology.

"Explanation and Demonstration of the Poulsen Telegraphone," by Z. B. Babbitt, New York city.

"The Electromagnetic Theory and the Velocity of Light," by Henry T. Eddy, University of Minnesota.

"Experiments on Resonance in Wireless Telegraph Circuits," by G. W. Pierce, Harvard University.

"The Ratio of Electrical to Gravitational Forces," by Bergen Davis, Columbia University.

"A Measurement of the Thomson Thermoelectric Effect in Iron," by Edwin H. Hall, Harvard University.

"A Contribution to the Theory of Thermo-electromotive Force," by C. B. Thwing, Syracuse University.

"The Tuning of Thermoelectric Receivers for Electric Waves," by A. D. Cole, Ohio State University.

"The Capacity and Resistance of Aluminum Anode Films," by C. McC. Gordon, Central University.

"Note on the Use of Sensitive Quadrant Electrometers," by J. C. McLennan, University of Toronto.

"On the Decay of the Excited Radioactivity from Natural Causes," by Miss L. B. Johnson.

"On the Secondary Radiation Excited in Metals by the Gamma Rays from Radium," by H. F. Dawes.

The "Question Box" of the National Electric Light Association.

Mr. Homer E. Niesz, editor of the "Question Box" for the Denver-Colorado Springs meeting of the National Electric Light Association, has sent out over 7,000 letters to companies and individuals in the electrical field asking them to submit questions to be grouped under the following headings:

A—Buildings.
B—Water-wheels, water power, etc.
C—Feed water, heaters and pumps.
D—Fuel.
E—Boilers and mechanical stokers.
F—Forced draught, blowers, stacks.
G—Piping, condensers, etc.
H—Engines.
I—Turbines.
J—District heating.
K—Generators and exciters.
L—Storage batteries and boosters.
M—Switchboards, instruments and station wiring.
N—Belts and shafting.
O—Oil and waste.
P—Overhead lines.
Q—Underground lines.
R—Transformers.
S—Lamps—arc, incandescent, etc.
T—Heating, battery charging and power.
U—Meters.
V—Advertising.
W—Contracts and rates.
X—Accounting and statistics.
Y—Management.
Z—Miscellaneous.

Mr. Niesz not only desires questions from those seeking information, but he appeals to the missionary spirit in those who have solved difficulties for themselves, and asks them to send questions to which they have found solutions, together with the replies, for the benefit of others.

Electrical Contractors' Association of New York State.

The Electrical Contractors of New York State will meet in annual session at Troy, January 17, 1905, as the guests of the Eastern New York Local. It is expected on that occasion to have a large number of members in attendance, and also several officers of the National Electrical Contractors' Association, with others prominent in the electrical field. A souvenir programme of the meeting and entertainment will be issued. The committee at large is as follows: F. W. Newman, M. Havens, Jr., T. H. Bell, M. L. Barnes, V. S. Clute, E. E. Sheldon, A. J. Clute, A. L. Payton, F. L. Frost, J. F. Burns, W. C. Finch, W. F. Hahn, A. H. Morrison, Seymour Taylor, E. G. Bernard, Frank L. Welch.

INDUSTRIAL SECTION.

ILLUSTRATED DESCRIPTIONS OF NEW AND STANDARD ELECTRICAL AND MECHANICAL APPARATUS.

The Ohmer Fare Register.

The Ohmer Fare Register Company, Dayton, Ohio, manufactures a fare register for which there are claimed many features of originality and great merit. The proposition of securing from an employé the full amount of cash represented by the fares collected during a car run is one which has taxed the ingenuity of inventive spirits for a number of years. Beginning with the simple manually-operated punch, the evolution of fare registers has gone on until there are now on the market many forms of elaborate registering devices, all designed for the protection of the company and the detection of dishonest or careless employés.

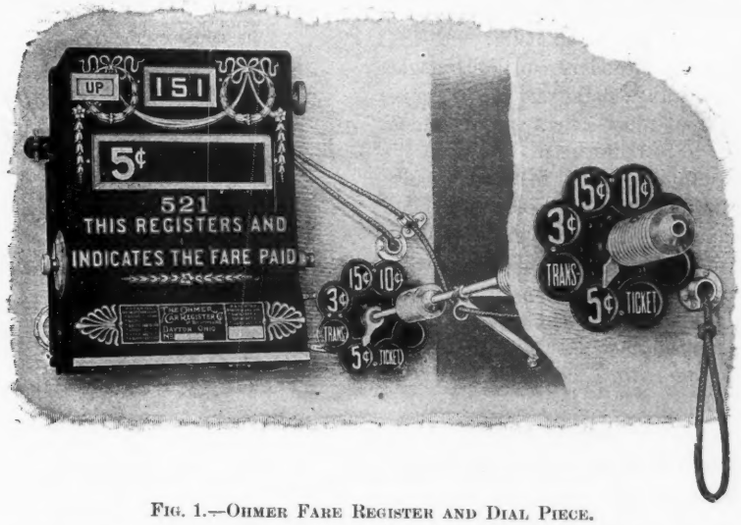


FIG. 1.—OHMER FARE REGISTER AND DIAL PIECE.

The Ohmer fare register carries out a number of essential operations in the handling of passenger traffic. Not only is this system applicable to inter-city runs, but for interurban service, where several rates of fare must be charged, the possibilities are very extensive.

The accompanying illustrations show the typical features of the Ohmer fare registering device. Fig. 1 shows the car register and the dial piece, which may be mounted in separate places. Fig. 2 shows the record which the register causes to be made.

This instrument makes separate registration for each fare collected, the different kinds of fare being registered separately. It keeps a separate printed record of the collections of each conductor. It shows a separate indicator for each kind of fare registered. The fares registered are simultaneously indicated at various places about the car—on the platform, on the inside of the partitions, or in special compartments of interurban cars. It makes a total registration of all fares, irrespective of the class. It indicates the direction in which the car is moving. It prints the number of fares in each class for each half-trip. It prints the trip number, the month and day, the number of the register, the number of each conductor, the number of the motorman if desired, and shows the platform time he takes and leaves the car.

The roads adopting the Ohmer register have the free use of the Ohmer system.

Fig. 2 shows the printed statement taken from the register at the close of each day. The vertical columns represent the different classes of fares which are marked above them. The single column at the left contains the trip numbers, while on the right the columns designate the number of the register, the month and day, and the badge numbers of the inspector and of the conductors who had the car during the day. The lowest row of figures indicates the statement of the register at the beginning of the day, as taken by the inspector, and the top row the statement at the end of the day. The conductors print impressions at the beginning of each trip, and also when they relieve one another and are relieved. The two rows of figures at the bottom are duplicates of the inspector's statement at the beginning and end of the day, respectively. They show the totals for the car, and may be used by the auditor or sent to non-resident officials. As the figures run consecutively, and the closing statement for one day is always the opening statement for the next, there is no loss of record if a sheet should be destroyed. The system includes a ledger page, on which the collections of a car in detail by conductors are entered; a monthly summary, on which the totals for the month of the separate cars are entered from daily report pages, and an annual summary. In addition to this there is a special record for the conductor's efficiency during the year, which is made the basis of promotion or dismissal.

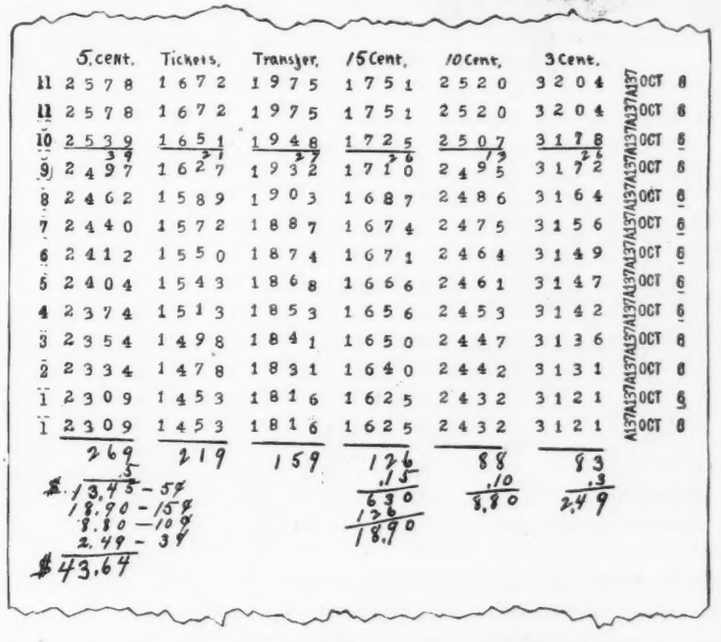


FIG. 2.—PRINTED STATEMENT FROM OHMER REGISTER.

Transformer for Thawing Out Frozen Water Pipes.

Within the last year or two considerable attention has been called to the application of electric currents to the thawing out of frozen water pipes. For this service, in almost every instance, a special form of transformer has been adopted. The large public service corporations have found it possible to establish a considerable revenue through this form of service.

In order to satisfy a demand for a special type of transformer the General Electric Company, Schenectady, N. Y., has placed upon the market a distinctive style of apparatus. This transformer is shown in the accompanying illustration.

The outfit has been designed to withstand rough handling and outdoor service.

TRANSFORMER FOR THAWING FROZEN WATER PIPES.

It is compact and, at the same time, all parts are accessible. Adjustments over wide ranges of both secondary voltage and current are readily made, and the outfit is simple to handle, portable and comparatively inexpensive.

The transformer is designed to operate on circuits varying from 2,000 to 2,300 volts, sixty cycles, and its secondary voltage and current may be readily adjusted from zero to seventy-five volts and zero to 400 amperes by means of an adjustable cord or flux shunt controlled by a handwheel and locking device.

The transformer core has three horizontal legs, with a closed magnetic circuit at the ends. Flat, pancake coils are threaded on the middle leg and spaced apart so as to permit an adjustable flux shunt to move up and down between the primary and secondary coils. This device constitutes a bridge, arranged to shunt a varying amount of the primary flux out of its normal path through the secondary coil. When the shunt is in the lowest position it diverts the primary flux from the secondary coil, but when in its highest position permits practically all the flux to thread the secondary coil. At intermediate positions, corresponding amounts of flux thread the secondary coil.

The leads of the primary coil are brought out to a suitable connection board on the side of the transformer. On this connection board are mounted primary switches, fuses and an ammeter. The terminals of the secondary coil are brought out to heavy lugs at the end of the transformer, from which cables can be run to the pipes to be thawed.

The outfit complete, including transformer, switches, cover and meter, weighs, approximately, 1,200 pounds. It is mounted on four broad, flanged wheels, to permit its being quickly loaded on a wagon bed or sleigh. The space occupied by the transformer is about twenty by thirty inches, with a height of thirty-six inches.

New Types of Plugs and Receptacles.

A new application of marine fittings is shown in Fig. 1 of the "Russell" waterproof floor receptacle and plug. The part section and part transparent cut shows the union nut carried by the plug, holding the plug securely in place in the box, and at the same time making a water-tight joint about the neck of the plug by means of the gasket. The smaller nut on top of the plug is a means for drawing a soft rubber cork into the taper neck of the plug to make a water-tight joint around the cable leading from the plug. This, it will be seen, not only cushions the cable outlet, but prevents foreign matter or moisture from entering the plug. When the plug is removed, a small flush cap carrying a gasket on the inner side is used to establish a water-tight surface to the box. These fittings are extremely compact, and have been designed to meet the general needs of floor outlets and easy installation. The company makes a specialty of water-tight receptacles, and a general line of marine lighting equipment.

Something novel in the form of stage receptacles or pocket is shown in the accompanying illustration, Fig. 2, which represents the "Russell quick-break pocket." This receptacle and plug has been designed to meet all the severe requirements of stage receptacle work, where twenty-five amperes or more are used from an outlet. The body part of this fitting is made of two heavy blocks of porcelain bolted together, and the inner surfaces of the porcelain blocks carry contact plates to which the feeding wires are attached by terminal screws at each side of the box. The porcelains have a centre opening or throat from top to bottom and directly between the contact plates, to receive the extension circuit plug. The plug is arranged with hinged contact

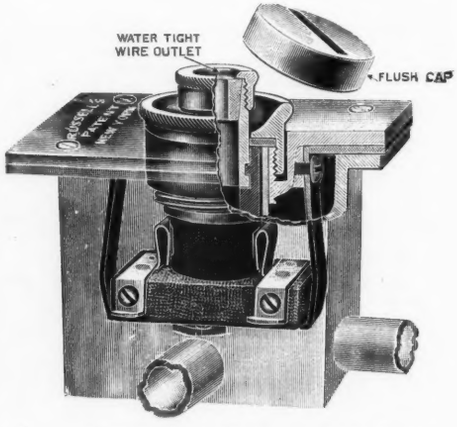


FIG. 1.—MARINE FLUSH RECEPTACLE AND PLUG.

arms, and when the plug is pushed into the throat of the box, these arms are thrown out and into contact with the terminals of the box. It will be seen from the illustration that the box terminals are widely separated and well away from the plug throat, so that when the plug is removed and the opening left open, any

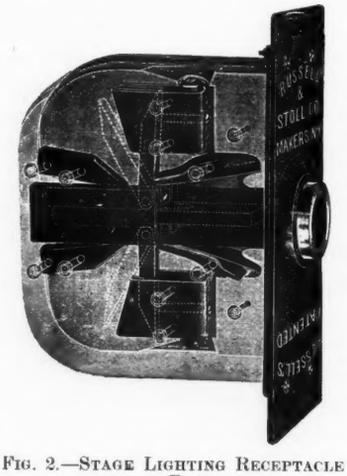


FIG. 2.—STAGE LIGHTING RECEPTACLE AND PLUG.

foreign matter falling into the throat can go on through and can not come in contact with the live parts. These fittings are a wide departure in construction and make-up from former devices of this kind, and are another of the interesting line of receptacles made by the Russell & Stoll Company, 48 Cliff street, New York city.

The Crouse-Hinds Harpoon Guy Anchor.

The Crouse-Hinds Company, Syracuse, N. Y., has recently placed upon the market a harpoon guy anchor for guying telephone, telegraph, electric light and trolley wire poles. The anchor is shown in the accompanying illustrations.

With this device it is unnecessary to bore or dig a hole in the ground. The anchor is driven into the ground with thirty or forty blows of a twelve-pound sledge. Although it is unnecessary, it is sometimes desirable to start a hole with a digging bar, in order that the anchor may be in a convenient position to be driven into the ground. The hole need not be more than two and one-half feet deep, nor more than four inches in diameter. When the anchor is driven full length into the ground, it is attached to the guy wire and pulled out a distance of about six inches until the wings spread.

The anchor is made of rolled steel, and weighs about twenty-two pounds. When closed, the wings measure four inches. Their spread is thirteen inches. The rod is one inch square and five feet long. The anchor is covered with a thick coating of non-corrosive paint. A large number of telephone and electric light companies are using this device.

FIG. 1.—HARPOON GUY ANCHOR, OPEN.

FIG. 2.—HARPOON GUY ANCHOR, CLOSED.

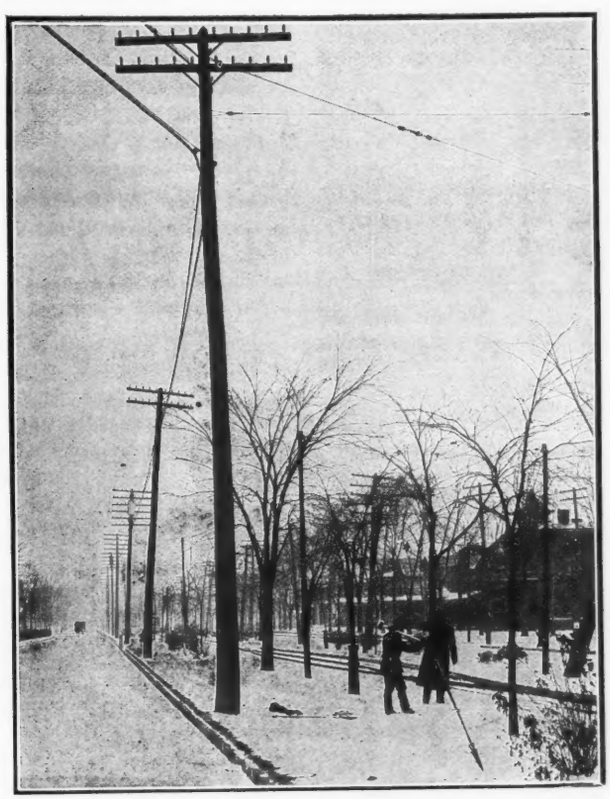


FIG. 3.—DRIVING HARPOON GUY ANCHOR.

The Record Run of the Westinghouse World's Fair Turbine.

A memorable incident of the morning following the close of the St. Louis Exposition was the formal shutdown and inspection of the 600-horse-power Westinghouse steam turbine generating unit in the Palace of Machinery after a continuous run of over 3,962 hours—a performance which has had no parallel in steam turbine history. This machine was started on its long run at 9.20 on the morning of Monday, June 20, shortly after its installation at the fair, and was stopped at 11.32 on the morning of Friday, December 2. During the five and one-half months that the unit was in operation it supplied current for light and power throughout the Westinghouse exhibits in the palaces of machinery, electricity and transportation. Charles F. Foster, chief operating engineer of the exposition, H. M. Holman, supervising engineer at the government exposition gas engine tests, formerly president of the St. Louis board of public works, and a number of Westinghouse representatives, including Wallace Franklin, of Detroit, C. C. Chappelle, of Chicago, and W. K. Dunlap, managing director of the Westinghouse exhibits, were present when the engine was stopped. It was found to be in perfect condition, and there were no signs of wear, the bearings still retaining the tool marks as they had come from the shops.

There have been at least two instances on record in America in which piston engines have been run continuously for about the same length of time as that of the record run of the Westinghouse turbine. The remarkable feature of the turbine run, of course, was the maintenance under load of a speed of 3,600 revolutions a minute for such a long period. From 8.30 in the morning to 10.30 in the evening, the load carried throughout the exposition varied from twenty-five per cent underload to twenty-five per cent overload. The total number of revolutions almost touched the billion mark—855,792,000.

Ammeter for the Secondary Current of Induction Coils.

The Rœntgen Manufacturing Company, Philadelphia, Pa., is introducing a milliampere-meter of the D'Arsonval type, which will measure accurately the current in the secondary of a Ruhmkorff coil. When used in connection with X-ray work, this meter makes possible a comparison of the exposure of patients to X-rays, as it has been found that the quantity of X-rays is proportional to the current which produces them.

The meter is adapted to any make of coil or static machine, as its indications are correct for both static machines and coils. Only unidirectional impulses from induction coils are permitted to flow in the secondary circuit of the meter, for if

the "inverse discharge"—so-called—is allowed to pass, the reading of the meter is the algebraic sum of the integrated positive and negative currents. The meter case and permanent magnet system are both grounded to one side of the moving coil and its shunt, thus causing the only difference of potential between the case of the instrument and its contents to be the drop in potential through the two coils. The difference of potential due to the self-induction of the moving coil is enough to cause sparking between its turns and from the coil to adjacent parts, if it were not shunted by a small mica condenser, which is of the correct value to neutralize the self-inductive effect of the moving coil. The drop through the moving coil is made approximately equal

MILLIAMPERE-METER FOR X-RAY WORK.

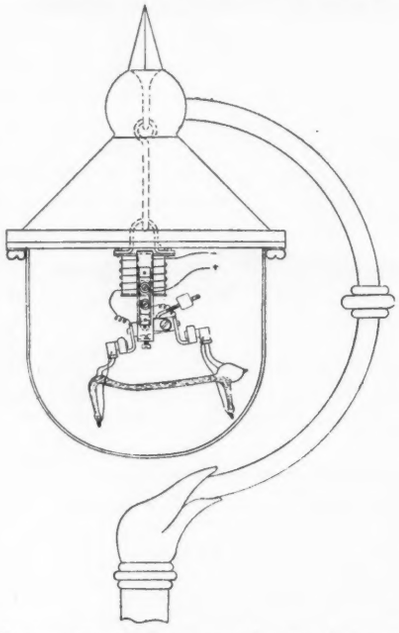
to its ohmic drop, and the only difference of potential between the parts of the meter is the difference due to the ohmic fall of potential in its coils.

The meter is supported upon an insulating standard, and the meter case, with all its contents, rises and falls in potential with the varying potential of the high-tension circuit. Thus it is charged only when the secondary wires are charged, and sparks may be obtained from the outside of the meter just as easily as from the secondary wires of the coil, although this does no harm to the meter.

James G. Biddle, 1114 Chestnut street, Philadelphia, Pa., is general sales agent for the Rœntgen Manufacturing Company.

A Mercury Vapor Lamp for Street Lighting.

The Bastian mercury vapor lamp, a type which is being developed in England, has now been put upon the market in a shape suitable for street lighting. The present lamp, an illustration of which is given herewith, operates at from 200 to 250 volts, direct current, consuming from 0.25 to 0.3 ampere. Its candle-power is



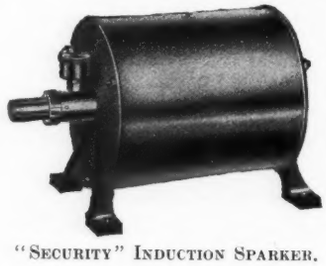
MERCURY VAPOR LAMP FOR STREET SERVICE.

said to be from 120 to 160. This type of lamp is not suitable for use on alternating currents, but the makers are now working on such a lamp.

The agents for the Bastian lamp are Rumney & Rumney, 31 Victoria street, London, S. W.

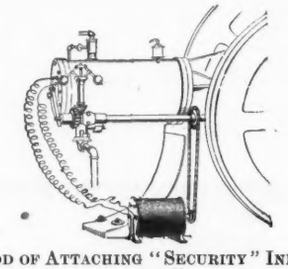
The "Security" Induction Sparker.

The F. Bissell Company, 226 Huron street, Toledo, Ohio, is placing on the market the "Security" induction sparker for gas and gasoline engines. The "Security" sparker, when used for butt sparks, is an induction dynamo furnishing an alternating current. The voltage is high—eight to ten on slow speed, and fifteen on high speed. The output is ten amperes, giving a large spark and making sure of ignition.



"SECURITY" INDUCTION SPARKER.

The machine is rugged in design, and its compactness calls for a small amount of space. It may be attached directly to the engine or placed in some convenient position on the floor, wall or ceiling. The apparatus is thoroughly enclosed, and protected from dirt, oil and moisture.



METHOD OF ATTACHING "SECURITY" INDUCTION SPARKER TO ENGINE.

The wiring is direct from the sparker to the engine, using no intermediate coil.

For driving the sparker, the apparatus is usually fitted with sprockets and chain.

The National Electric Company Secures a Valuable Air Brake Contract.

For a number of years steam railroads have used an air brake as their standard. Electric lines have experimented with various kinds of brakes, to make certain whether it was possible to improve upon this type of brake for their work. Suburban electric roads followed in the footsteps of the old organizations by adopting the air brake as their standard, the main difference being that the steam railroads use steam to compress the air for the brakes, while the electric roads rely upon an electric motor. When air brakes were originally tried by the electric roads, the manufacturers of these brakes relied upon a pump, which was fastened to the axle of a car to compress the air. This type of brake was tried a number of years ago on the Akron, Bedford & Cleveland line, but was not entirely satisfactory. The electric motor was then turned to in connection with the compressor to supply the air. Manufacturers have, for a number of years, been endeavoring to improve the motor and compressor, and have so far succeeded that if a road is willing to go to the expense of using this type of brake, very little risk is assumed by the operating company.

A number of the larger cities, such as Philadelphia, Buffalo and Detroit, have all their cars equipped with air brakes, some being installed as new and larger cars were purchased.

The Cleveland Electric Company has now placed the largest contract for individual air brake compressors that has ever been recorded in this country. This decision was arrived at after over two years of experimenting with practically every known type of brake that is manufactured. The National Electric Company, of Milwaukee, Wis., has been awarded this contract by the Cleveland Electric Company, and is now arranging to ship several carloads of air brakes, which will be installed immediately under the new convertible type of cars.

A New Westinghouse Crane Motor.

The Westinghouse Electric and Manufacturing Company has been closely identified with the problem of crane and hoisting service since its earliest inception, and has for more than a decade been actively engaged in the construction of electric crane machinery. Westinghouse apparatus has been extensively employed in such operations, and has met with the highest success.

Westinghouse type K motors are designed for the operation of cranes, hoists and similar apparatus and for intermittent service in which heavy starting torque and wide-speed variation are required. They represent the latest development and include the most recent improvements in machinery of this kind. Many new features of the highest practical value have been incorporated in their construction. They are strong and compact, convenient to install, adaptable to every practical form of mounting, and are reliable, economical and powerful in operation. Ten sizes are standard, including capacities from two to forty horse-power.

The frames are of the wholly enclosed form, to guard against dirt and moisture, but are so designed that the working parts may be exposed for inspection or adjustment without dismantling. If local conditions permit, the cover about the commutator may be removed and the motor operated open, with improved ventilation and increased capacity.

Type K motors have four inwardly projecting poles, each of which is magnetized by a separate field coil, are series wound and are designed for operation on direct-current circuits of 200 and 500 volts. Since the current passes successively through armature and field-winding, the torque of such a motor increases nearly as the square of the current, up to the point of saturation of the iron. For this reason the series motor is particularly well suited to the starting and acceleration of heavy loads. Governed by change of voltage at the motor terminals, the speed of the motor is carried through a wide range.

The motor frames are of cast steel (except in the three smallest sizes, where they are cast iron). They are extremely compact, nearly square in section and require the smallest amount of head-room on a crane, or floor space when used with hoists or similar apparatus. Two poles project inward in a horizontal and two in a vertical plane, this arrangement being the most compact possible with a four-pole motor. The frame is built in two parts, divided in a plane passing through the axis of the armature and at an angle of thirty-four degrees with the horizontal, an arrangement which allows the upper half of the field to be removed without disturbing the gears or shaft, and makes it easy to take out a pole-piece and field coils, or to remove the armature. The lower half of the frame has four feet, with holes for bolting to the support, providing the smallest base consistent with good engineering practice. The lower casting has also two finished faces or pads to which bearings for a countershaft may be bolted, or which may be used for side mounting. The commutator end of the frame is connected to the poles by six ribs, any two of which may carry the brush-holders. The opening around the commutator is entirely closed by a three-thirty-second-inch sheet-steel band, fastened by thumb screws, an arrangement which permits access to the commutator and brush-holders at all points.

The four pole-pieces are built up of soft steel punchings, riveted together between wrought iron and plates, and are secured to the frame by bolts which pass well into the punchings, but leave the pole-face smooth and unbroken. The coils of the larger motors are of copper strap and the terminals are insulated with asbestos ribbons. Being machine wound, they are perfectly interchangeable. The coils are fitted to the pole-pieces, protected at the ends by oiled duck and held in place by the spreading tips of the pole-pieces.

Shells lined with bronze or babbitt and mounted in housings which may be removed without separating the motor frame, constitute bearings of particular merit and splendidly adapted to the service for which these motors have been designed. Great strength has been provided, with the wear distributed over a large surface, so that the bearings are suitable for the most severe service. Cast-brass bearings are standard on all sizes up to and including the No. 4; on all frames above No. 4 babbitt bearings are used. Grease lubrication is employed in all except the larger sizes—Nos. 9 and 10—the bearings of which are designed for lubrication by oil and waste. Drip cups are provded under the bearings on all motors. The bearing housings may be turned and bolted in several positions without modifications of design or the addition of special parts.

The armature core is built up of soft steel punchings of high permeability, carefully annealed by a special process. These punchings are, in all except the smallest sizes, assembled on a spider and held from turning by a steel key. The pinion end is provided with a bell-shaped flange, which forms a support and shield for the armature coils. Ducts between the punchings are provided through which air, drawn in through openings in the spider, is forced out against field coils and core, maintaining a uniform temperature throughout all parts of the motor. The commutator is mounted on the armature web, allowing the shaft to be removed without disturbing the winding or connections. The coils are placed in slots and retained by bands laid in grooves below the surface of the core, except in the case of armatures for the Nos. 9 and 10 motors, which have fish paper wedges forced in between V-shaped grooves near the top of the slots Covers of oiled duck adequately protect the ends of the winding. Wiper rings or oil guards are provided at each end of the armature to protect the winding from oil.

The shafts are of great strength and may be extended at either end to accommodate pulleys, pinions or brake discs.

The commutator is built up of bars of hard-drawn copper, insulated by prepared mica, and mounted on the armature spider. The commutation is particularly good, in spite of the heavy rushes of current to which a motor of this class is subjected.

The brush-holders of type K motors are of the sliding type and possess many features of peculiar merit. The individual holders may be independently adjusted. Tension is provided by means of a coiled spring which acts through a short brass strip, so that the spring responds immediately to any movement of the brush, and close contact is maintained at all times. The brush-holder arms are secured by stud-bolts to surfaces which are machined on the ribs of the frame, parallel to tangents at the points of contact with the brushes. Adjustment to compensate for wear of the commutator can be made by removing the iron washers which are placed under the insulating washers on the stud-bolts.

With all but the two smaller sizes (frames Nos. 1 and 2) a shunt is connected to the tip of the spring, extended back over the spring and securely fastened to the brush-holder, thus relieving the spring of the duty of carrying current, ensuring good contact, low operating temperature and a permanent and even tension. With every carbon brush five-eighths inch or more in thickness an additional sheet is provided connecting the carbon itself to the brass holder, improving the contact between carbon and holder and preventing pitting of the brush. Flexible leads are brought out through insulating bushings in the upper frame and are either connected to terminal blocks mounted on the top of the motor or are arranged for direct connection to the controller lines.

CURRENT ELECTRICAL NEWS

DOMESTIC AND EXPORT.

COLORADO TELEPHONE COMPANY INCREASES CAPITAL—The Colorado Telephone Company has increased its capitalization from $5,000,000 to $10,000,000. This has been done in order to provide reserve capital for contemplated extensions and improvements.

PROJECTED ELECTRIC RAILWAY IN THE ALPS—K. Muller, Ad. Tschan and G. Holliger, of Soleure, Switzerland, have secured a concession for the construction and working of an electric funicular railway from Oberdorf to the top of the Weissenstein, the cost of the construction being about $140,000.

CHICAGO RAILROADS CONTROLLED BY EASTERN CAPITAL—It is announced that the North and West Chicago street railway companies are controlled by eastern traction interests. Fifty-four thousand shares, out of a total of 79,020, of North Chicago railroad, and 69,000 out of a total issue of 131,890 of West Chicago railroad, are credited to the eastern men.

ELECTRIC LIGHT PLANT IN CULIACAN, MEXICO—A concession has been secured from the state of Sinaloa, Mexico, by a number of San Francisco parties to build an electric light plant in the city of Culiacan. For this purpose the Culiacan Electric Company has been incorporated at San Francisco with a capital stock of $300,000. The incorporators are: I. Gutte, F. G. Brane, H. Hacke, Henry Eichoff and Sidney Sprout. Work is to be commenced within three months and completed in one year.

SYRACUSE, LAKESIDE & BALDWINVILLE RAILWAY—It is announced that the property of the Syracuse, Lakeside & Baldwinsville Railway has been acquired by a syndicate composed of the men who own the Auburn & Syracuse and the Rochester, Syracuse & Eastern roads. The purchase price was $550,000. The new owners will not take possession of the road until the trustee of the bonds has foreclosed the mortgage on it, which will probably take five or six months. The new company will probably be known as the Syracuse & Ontario Railroad Company, and expects to extend the line three miles and to make numerous improvements to the present system.

NEWS NOTES FROM MEXICO—A concession has been secured for a local and long-distance telephone system extending throughout the state of Sinaloa. Large modern telephone exchanges will be installed at Culiacan and Mazatlan. Another concession is for an electric street railway system in Culiacan, and suburban electric roads. Work on the electric railway must be begun within one year, and at least two miles of the street line must be opened to the public within two years. Major George B. Burbank and George Stuart Simons, of New York city, A. S. Harvey, of Leadville, Col., are to establish electric and power plant at the Malinaltango falls, near the city of Mexico. About 25,000 horse-power will be generated.

FRANCHISE GRANTED FOR SIXTH AVENUE SUBWAY, NEW YORK CITY—The board of Rapid Transit Commissioners, New York city, has granted to the New York & New Jersey Railroad Company a franchise to build a tunnel up Sixth avenue from the terminus of its Hudson river tunnel, at Greenwich and Christopher streets, to Thirty-third street. The franchise is of twenty-five years' duration. A perpetual franchise was also granted to the same company to build a cross-town tunnel under Christopher and Ninth streets to Second avenue. For the first ten years the company is to pay fifty cents per foot of track and station platform, and also $9,000 a year, which is three per cent of the estimated gross earnings of $300,000 per year. For the succeeding fifteen years the company is to pay one dollar per foot of track and station platform and five per cent of the estimated gross receipts, the estimate to be made at the expiration of ten years upon the basis of the information then available as to actual traffic conditions.

ELECTRIC RAILWAYS.

ALBANY, N. Y.—The Schenectady Railway Company has applied for a franchise in Ballston.

SPRINGFIELD, OHIO—Seven miles of track have been laid on the Springfield & Chillicothe traction line.

FREDONIA, N. Y.—The Dunkirk & Fredonia Railroad Company is starting the foundations for a large addition to its power-house.

PHILADELPHIA, PA.—Capitalists of this city have formed a syndicate with a view to building a trolley line from Reading to Pottstown.

CORRY, PA.—A trolley line is talked of between this city and Columbus. Several Chautauqua County men have made a request for a franchise.

ST. LOUIS, MO.—L. C. Haynes, vice-president of the East St. Louis & Suburban, states that the company has decided to build a connecting electric line to Troy, Ill.

MARSHALL, MICH.—Joseph J. Leavy is projecting an electric railroad from here to Coldwater *via* Lyon Lake and Tekonsha. Property owners along the route have donated a right of way.

SPOKANE, WASH.—A plan is reported for the construction of an electric line from the Homily rapids, three miles north of Wallula, into the Horse Heaven section, a distance of about forty miles.

FAIRFAX COURT HOUSE, VA.—The Washington, Arlington & Falls Church Railway Company has extended its line to this place, which gives a continuous trolley line to the Aqueduct bridge at Washington.

BUFFALO, N. Y.—The project of building a trolley line that will connect Ellicottville and East Otto has been revived. It is hoped to enlist interest and continue the projected line from East Salamanca to Springville.

SPOKANE, WASH.—One of the plans under contemplation by the management of the Cœur d'Alene & Spokane Railway Company is the running of a branch electric line from the present Cœur d'Alene road to Rathdrum, Ida.

PITTSBURG, PA.—Work on the survey of the proposed Monongahela, Ellsworth & Washington street car line has been begun. All rights of way have been secured and it is the intention to push the work to completion as fast as possible.

MEMPHIS, TENN.—F. R. Harris, L. G. McNair, Corwin H. Spencer and J. G. McGannon, of St. Louis, and others asking for a franchise for a new street railway have accepted the city council's condition, and have posted $50,000 guarantee.

WARSAW, IND.—In addition to the electric line which is now operated between Winona lake and Warsaw, and its proposed line between Warsaw andd Goshen, the Winona assembly may build a line from Warsaw either to Peru or to Wabash.

ROCKLAND, MASS.—Charles H. Killam, of Assinippi, and C. L. Stevens, of this town, are at the head of the movement to build an electric line from Assinippi to Scituate harbor. Mr. Killam expects to see the road built by another year.

TROY, N. Y.—The officials of the Schenectady Railway Company have decided to build a line from Lathems, on the Troy division, northerly to a point where it will intersect a line proceeding eastwardly from Dunsbach's Ferry. The line will continue down to Cohoes.

DAYTON, OHIO—Pursuant to a call from the board of directors of the Dayton & Northern Traction Company the stockholders of the company, at a recent meeting, took favorable action on a resolution of the board of directors adopted October 11, to increase the capital stock of the company in the amount of $100,000, by the issue of one thousand shares of preferred stock

of the par value of $100 each, to bear dividends at the rate of five per cent per annum. This is to come out of the annual profits of the company, before any dividends are paid other stockholders, the dividends on preferred stock to be cumulative.

METUCHEN, N. J.—Agents are at work getting consents for a private right of way for the trolley line to be built by the Short Line Company from Milltown, through this place, to Elizabeth. The line is to be the continuation of the Trenton & New Brunswick Fast Line.

SYRACUSE, N. Y.—The Syracuse Rapid Transit Company is to double-track a number of its single-track lines next spring. With the present single tracks, the service can not be given which the heavy traffic demands. A large number of double-truck cars have also been ordered.

SKIPPACK, PA.—The Trooper, Skippack & Souderton Trolley Company, at a meeting held here, decided to increase the capital stock of the company from $100,000 to $300,000, and agreed to the increase of the bonded indebtedness from $200,000 to $500,000, made as a provision in case of the ultimate extension of the road.

BOSTON, MASS.—The Western Massachusetts Street Railway Company has been granted a charter by the Massachusetts secretary of state. It is capitalized at $300,000, will be forty miles in length, and will run from Westfield through the towns of Russell, Chester, Huntington and Becket to Lee.

TEMPLETON, MASS.—The Templeton street railway, which has been in the hands of a receiver, has been sold by a deputy sheriff to William E. Barrett, of Boston, for $112,000 to satisfy an execution in his favor. The road is in operation between Gardner and Athol. Mr. Barrett, who is the principal stockholder, was the only bidder.

LA GRANDE, ORE.—The La Grande city council has approved a franchise for a right of way into the city limits to the Eastern Oregon Development Company for the electric railway to run from Union to Cove, Summerville, Elgin, Island City and La Grande, and probably Hot Lake Sanitarium. Under the agreement the work is to be completed to Cove by 1905.

SAN LUIS OBISPO, CAL.—At a meeting in this city F. S. Granger, of Santa Cruz, made a proposition to build an electric railway to Avila Beach at the Port Hartford government breakwater, ten miles from this city. He proposed to put in a railway costing $25,000 per mile, and asked a bonus of $50,000. A committee of five citizens was appointed to consider the proposal.

ATLANTIC CITY, N. J.—A trolley line between Absecon, where the Atlantic City line terminates, and Hammonton, twenty-two miles toward Camden, is contemplated. Philadelphia and New York capitalists are said to be behind the enterprise. High-power motors, capable of driving cars at a rate of fifty miles an hour, are to be adopted. The route has been surveyed across private property.

DENVER, COL.—By the incorporation of the Northern Colorado Construction Company, at Fort Collins, a new line of road is to be constructed in the sugar-beet country. The incorporators are C. W. Waterman, W. N. Valle, E. N. Clark, D. A. Chisholm and H. D. Dunham. The directors for the first year will be C. S. Morey, Charles Boettcher, M. D. Thatcher, W. A. Dixon and C. W. Waterman.

GREENVILLE, PA.—The promoters of the Greenville trolley system are sanguine that work will begin soon, provided franchises are granted in Sharon, South Sharon, Wheatland and West Middlesex. The name of the line will be changed from the Greenville Electric Railway Company to the Shenango Traction Company. C. G. Hussey, of Pittsburg, and H. M. Adams. of Cleveland, are the incorporators of the Greenville line.

BENTON HARBOR, MICH.—A party of Chicago capitalists, claiming to represent a syndicate of eastern capitalists, is interested in an electric line from this city to South Haven along the lake shore, with a spur running to Paw Paw lake and Watervliet. They say capital is ready to build the road at once. The road will enter Benton Harbor along the Paw Paw river and cross the canal midway between here and St. Joseph.

DECATUR, IND.—At a meeting of the stockholders of the Springfield & Fort Wayne Interurban Railway Company it was decided to issue $500,000 worth of gold-bearing bonds for the placing of $156,000, of which arrangements had already been made. These bonds will enable the company to complete the road more rapidly. The grade has been completed and bridges built and at present a power-house is being constructed at Decatur, Ind.

LONGMONT, COL.—The Northern Colorado Electric Railway Company, which was recently granted a franchise by the Longmont city council, has filed with the city clerk here a map of the proposed route within the city limits. The map shows a line on the outskirts of the city for freight traffic, and a connecting line in the city that takes in the business and residence portions of Longmont. It is said that money has been secured with which to build the road.

ST. LOUIS, MO.—After an inspection of the proposed route of the St. Louis, Webster Groves & Valley Park Railway Company, W. T. Markee, of the firm of Markee & Company, of Philadelphia, announced that his company would finance the road, and that work of construction would commence at once. It is expected that the new road will be in operation to Kirkwood by May 1, and to Valley Park six weeks later. Connection with St. Louis will be made with the Chouteau avenue line of the United Railways. The route to Valley Park from the city limits is fifteen miles.

IRON MOUNTAIN, MICH.—William A. Lombard, of New York, representing Boston capitalists, has notified Mayor Cruse of the early intention of his company to apply to the city council of Iron Mountain for a franchise authorizing the construction and operation of an electric street railway within the limits of the municipality, the term of the proposed ordinance to be thirty years. Authority to establish an electric lighting and a gas plant may also be requested. As planned the railway is to be part of a continuous line connecting Niagara, Quinnesec, Norway, Vulcan, Loretto and other near-by Menominee iron range towns.

WALLA WALLA, WASH.—Edward S. Isaacs has applied to the board of county commissioners of Walla Walla County for a franchise for an electric line on the roads leading from Walla Walla to Milton and Waitsburg. It is stated that the company Mr. Isaacs represents will commence work within sixty days on the electric system in Walla Walla, it having already secured a franchise on most of the streets there. It afterwards proposes to take up the construction of interurban lines. The power for these lines will be obtained from the plant now being installed by the Northwestern Gas and Electric Company on Walla Walla river, which is expected to be ready for use soon after the first of the year.

DETROIT, MICH.—Mason L. Brown has completed the survey of the Adrian & Ann Arbor electric railroad, which will connect these two cities, running through Sabine, Macon and Tecumseh. The company has secured the right of way and partly completed grade of the Berry line, an extension of the Detroit & Eel River Railroad, from Logansport, Ind., to Detroit, which was abandoned. The officers and directors are: president, Charles R. Miller, Adrian; vice-president, M. R. Bacom, Wyandotte; secretary, Henry W. Lake, Detroit; treasurer, William Gartner, Wyandotte; general manager, John C. Howell, Macon. The work of construction will be commenced this winter if the weather permits. This line will give Ann Arbor and neighboring places a short electric connection with Toledo, through the Toledo & Western, from Adrian.

MARION, IND.—Another electric interurban railway, the Marion & Eastern, will be constructed from Marion to an important oil and farming district. The proposed new line will extend east from Marion, passing through Van Buren, Warren and Bluffton, and into the Ohio oil field, with its eastern terminal at Van Wert, Ohio. The line will pass through the best of the Indiana and Ohio oil fields and through an excellent agricultural country, thickly populated with many small towns and villages. The promoters of the line are the same men who promoted and built the Marion & Wabash traction line, recently completed and now in operation. The company is composed of G. A. H. Shideler, R. E. Breed and W. B. Dodds, of Marion; Jilson J. Coleman, formerly of New Jersey, president of the Northern Traction Company, who now lives in Marion; George Breed, of Philadelphia, and Harrison Williams, of Philadelphia.

ENGINEERING SOCIETIES.

FORMATION OF THE INDIANA ELECTRIC RAILWAY ASSOCIATION—The Indiana Electric Railway Association was organized on December 9. A preliminary meeting was held in November. The first regular meeting will be held on January 12, 1905, at Indianapolis, Ind., when officers will be elected. A committee now has charge of the affairs of the association. It consists of Gardner F. Wells, general manager, Terre Haute Electric Company; Paul H. White, general manager, Indianapolis & Martinsville Rapid Transit Company; C. C. Reynolds, general manager, Indianapolis & Northwestern Traction Company; J. W. Chipman, general manager, Indianapolis & Eastern Traction Company; A. L. Drum, general manager, Indiana Union Traction Company.

COLUMBUS, OHIO, BRANCH AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS—On December 5 the Columbus branch of the American Institute of Electrical Engineers held a regular meeting at the office of the Columbus Railway and Light Company. An interesting paper on "Comparison between European and American Engineering Practice" was read, bringing out a very interesting discussion. On December 19 this branch held a very interesting meeting at which a paper was read on "Purchased Electric Power in Factories." The discussion on this paper was interesting, owing to the presence of some warm admirers of steam-driven plants, also a manufacturer of gas engines. The next meeting of the Columbus branch will be held on January 9, 1905.

EDUCATIONAL.

THE POLYTECHNIC INSTITUTE, OF BROOKLYN—The Polytechnic Institute, of Brooklyn, College of Arts and Engineering, has issued a series of pamphlets bearing on the nature of instruction carried on at that institution. These pamphlets are entitled, as follows: "The Demand for Chemists and How It May Be Met," "Evening Courses in Electrical Engineering," "Electrical Engineering; Its Opportunities and How to Grasp Them," "Seven Questions on Matters Financial," "Mechanical Engineering and Its Professional Possibilities," "Important Points of Information," "Civil Engineering, What It Asks and What It Offers." These pamphlets may be had from F. W. Atkinson, Ph. D., president, Brooklyn, N. Y.

PERSONAL MENTION.

MR. H. WORKMAN, Los Angeles, Cal., has been appointed assistant manager of the Seattle-Tacoma Power Company, Seattle, Wash.

MR. J. G. WHITE, of J. G. White & Company, 43 Exchange Place, New York city, returned from Europe on Friday, December 23.

MR. J. J. ESTABROOK has been appointed to succeed Mr. H. J. Brewer as manager of the New York branch of the Holtzer-Cabot Electric Company, Boston, Mass.

ALONZO BURT has resigned his position as president of the Missouri & Kansas Telephone Company. He is also president of the Wisconsin Telephone Company, and will now devote his entire time to it.

MR. WORTH ROGERS, of Mt. Sterling, Ky., has invented a repeating telegraph instrument. This device automatically repeats the message to the sender, making possible the detection and correction of errors.

MR. HARRY D. REED, superintendent of the Bishop Gutta Percha Company, was married on December 15 to Miss Emelie Carrier, daughter of Mr. and Mrs. Osceola Carrier, at the residence of the bride in Newark, N. J.

MR. R. J. FLEMING has been appointed general manager of the Toronto Railway Company. He will assume his new position on January 1, 1905. Mr. Fleming is now commissioner of assessment and property of the city of Toronto, Ontario.

MR. C. W. WHITNEY has become identified with the Abner Doble Company, San Francisco, Cal., engineer and manufacturer of tangential water-wheels and needle-regulating nozzles. Mr. Whitney will have charge of the Abner Doble Company's publicity department.

MR. H. S. MONTGOMERY, for some time past manager of the New York district office of the Payne Engineering Company, has resigned his position to become interested in the Rogers Manufacturing Company, 147 West Twenty-third street, New York, manufacturer of the "Giant" hand punch.

DR. H. S. HELE-SHAW, recently head of the faculty of engineering at Liverpool (England) University, has resigned to take charge of the new Transvaal Technical Institute, which is to be established at Johannesburg. Dr. Hele-Shaw will leave for South Africa early in the coming year.

MR. H. R. BOYLE, paymaster of the Canadian Niagara Power Company, has resigned this position and leaves in January to accept an appointment in Toronto, Canada, with Mr. Cecil B. Smith, who was formerly resident engineer with the Canadian Niagara Power Company at Niagara Falls, Ontario.

MR. W. J. McMANIGAL has been appointed general manager of the new electric light and power department of the Maryland Telephone and Telegraph Company in Baltimore. He was formerly general manager of the large plant at Omaha, Neb., and superintended the construction of the $6,000,000 plant that is being built at St. Louis.

MR. J. B. McCLARY, of Birmingham, Ala., for nineteen years manager of the Birmingham Railway, Light and Power Company, has been appointed general manager of the Sheffield Interurban Electric Railway Company to succeed Mr. L. H. McIntyre, resigned. Mr. McClary will also have supervision of the electric light plant and waterworks.

MR. H. M. LITTEL, general manager of the United Railways, Light and Water Company, of Chattanooga, Tenn., has accepted the position of vice-president and general manager of the San Antonia Traction Company, also the San Antonia Gas and Electric Company, of San Antonia, Tex., of which company Mr. Emerson McMillin, of New York city, is president. Mr. Littel will assume his new office early in January.

MR. GISBERT KAPP, editor of the *Elektrotechnische Zeitschrift*, and general secretary of the Berband Deutscher Elektrotechniker, has been appointed to the chair of electrical engineering at the Birmingham (England) University. Mr. Kapp is the well-known author of a number of electrical books. Upon his return to England he will take up his work as a consulting engineer, which he gave up when he left England in 1895.

PROFESSOR HARRIS J. RYAN has been called to the head of the department of electrical engineering at Stanford University, Palo Alto, Cal. Professor Ryan has resigned his professorship at Sibley College, Cornell University, Ithaca, N. Y. Professor Ryan will bring to Stanford University the highest possible acquirements for working in this field. Not only has he been a most successful instructor, but in research and experimental work his efforts have placed him among the foremost investigators of the day.

DR. F. A. C. PERRINE addressed the Commercial Club, of Boston, Mass., on the evening of December 15, on the theme of "Long-Distance Transmission of Water Power." Dr. Perrine commented upon the unavailed sources of power throughout the New England states. There was large probability, he thought, of New England increasing her manufacturing possibilities by reason of the development in the future of these sources of power. The meeting was presided over by Professor Elihu Thomson, and the attendance included many of the most prominent business men of Boston.

MR. J. U. JONES, of Dallas, Tex., one of the best-known salesmen in the Southwest, has joined the staff of the Allis-Chalmers Company, at Milwaukee, Wis., and will hereafter represent the company and its widely varied products in Texas and its tributary territory. Mr. Jones has had a wide experience in business. He began his business life as a machinist in the locomotive department of the Texas & Pacific Railroad. Then for nine years he was superintendent of the plant of the Paris Gas and Electric Light Company. Leaving that position he built the Crook-Record plant in Paris, Tex., and operated it as manager for two years in opposition to the older plant. A combination of the two plants was effected through the efforts of Mr. Jones, who managed the two for a year afterward, as superintendent. The next event in his business career was his joining the Southwestern Electrical and Construction Company, of Dallas, Tex., as traveling salesman, and superintendent of erection for the plants which the firm installed. Leaving that firm he was for three years in a similar capacity with Collins

& Delaney, of Paris, Tex., and later with the Murray Company, remaining with the latter concern until the time of making his present arrangements with the Allis-Chalmers Company.

MR. H. SCHIFFLIN has recently been made assistant manager of the mining and crushing machinery department of the Allis-Chalmers Company, with headquarters in the New York Life Building, Chicago. Mr. Schifflin's connection with the mining and crushing machinery business began in 1886 when he entered the employ of the old Fraser & Chalmers firm as a draughtsman. After several years' experience there he joined the Chicago Iron Works as draughtsman and estimator, and in 1894 when these works were acquired by the Gates Iron Works Mr. Schifflin was employed as a draughtsman and later as estimator and salesman. Mr. Schifflin has therefore been in the employ of the Allis-Chalmers Company or some of its constituent companies continuously during the last eighteen years.

MR. W. L. LOVELAND, the newly appointed head of the mining and crushing machinery department of the Allis-Chalmers Company, is widely known among mining men, and few men have the good fortune to be so well liked. He has at command all the benefits which come from both a technical and practical training, and his acquaintance extends from city men to those who operate plants in the wilds of the mining countries. Mr. Loveland was graduated from the University of Michigan in the class of 1882, and spent the following eight years as a mining engineer and metallurgist, being actively employed during this time in mining and the erection and operation of mills and smelters. While so employed he gained a practical knowledge of the operation and construction of mining machinery, and the requirements of the mining public. In November, 1890, he entered the employ of Fraser & Chalmers, of Chicago, manufacturers of mining machinery, as mining engineer and salesman, remaining in the employ of this company until February, 1897. He then entered the employ of the Winrow Gold Mining Company as superintendent to erect and operate a concentration mill. In June of the same year he was appointed to the position of manager of the mining machinery sales department of the Gates Iron Works, Chicago. He remained with this company until 1901, when there was a consolidation with the present Allis-Chalmers Company, at which time he was appointed head salesman in the mining machinery department of the Chicago office. Mr. Loveland took up his new duties as manager of the mining and crushing machinery department on October 18 at the main offices of the Allis-Chalmers Company, Chicago.

OBITUARY NOTICES.

MR. CHARLES ROBERT PENNINGTON died at Phœnix, Ariz., on November 30. He was a son of the secretary of the American Street Railway Association, Mr. T. C. Pennington. About a year ago he contracted a severe cold and has been a sufferer ever since. He was paymaster and cashier of the Chicago City Railway Company, and had been in the employ of the company for over twenty years. He leaves a widow and two children.

MR. W. FORMAN COLLINS, vice-president and general manager of the *Western Electrician*, died suddenly on the morning of December 21. While not in perfect health for some years he was apparently enjoying good health, when he suffered an apoplectic stroke, dying instantly. Mr. Collins was born on September 14, 1867, in Suffolk, England. His father was a prominent lawyer in England. After receiving a good technical education, and a sound training as a mechanical engineer, Mr. Collins came to the United States when a young man, and entered the services of the Cullendar underground cable interests. He also engaged in the design of electrical machinery, and was identified with some of the Waddell-Eutz machines and other electrical apparatus. He soon became interested in journalism, and served first upon the *Electrical World*, and then upon the *Electrical Engineer*. In 1890 he went to Chicago as the western representative of the last-named journal. In 1892 he purchased a large interest in the *Western Electrician*, of which he was made vice-president and business manager. Mr. Collins was a man of high character and ideals. He was a devoted husband, and had won a high place in the personal esteem of a wide circle of friends and acquaintances. Funeral services were held December 23 at the Trinity Reformed Episcopal Church. The body was taken to Albany, N. Y., for burial.

ELECTRICAL SECURITIES.

Last week was holiday season in the stock market, the short week showing a decided apathy in all directions in sharp contrast with the activities of the preceding weeks. Taken all together the closing price quotations show net declines, but with not apparent haste to liquidate. Unmistakable evidences of stability and strength have also given the check to bear aggressiveness wherever this was developed. It is quite probable that considerable "marking time" will be indulged in pending the outcome of the many agitations that will now be in order in the direction of federal regulation for financial and other corporations. The problem of the national government introducing radical innovations in the control of transportation facilities is thought by many to be receiving more serious consideration by the administration than ever before, even though it is an old story. In the railroad world the declaration of a dividend in Reading common, and the payment of a dividend by two of the smaller Vanderbilt roads, is taken as an indication of a bettering business. Gross earnings for all roads for the month of November make the best showing for any month of the year. There is also apparent an increased activity in the iron and steel trade, and reports are current that the big steel producers have booked orders that will keep them busy for the next six months.

ELECTRICAL SECURITIES FOR THE WEEK ENDING DECEMBER 23.

New York:	*Closing.*
Brooklyn Rapid Transit	60⅛
Consolidated Gas	196½
General Electric	185
Interborough Rapid Transit	164
Kings County Electric	206
Manhattan Elevated	163½
Metropolitan Street Railway	120
New York & New Jersey Telephone	166
Westinghouse Manufacturing Company	195

Boston:	*Closing.*
American Telephone and Telegraph	146½
Edison Electric Illuminating	251
Massachusetts Electric preferred	57
New England Telephone	136
Western Telephone and Telegraph preferred	99

A dividend of $1.50 per share and an extra dividend of 75 cents per share will be paid on Monday, January 16, 1905, to stockholders of record of the American Telephone and Telegraph Company at the close of business on December 31, 1904. The transfer books will be closed from January 2 to January 14, both days inclusive. Coupons of the 4 per cent collateral trust bonds of the company, by their terms payable January 1, 1905, at the office of the treasurer in New York, will be paid by the Manhattan Trust Company.

At the annual meeting of the Massachusetts Electric Companies, the following trustees were reelected for a term of three years: Gordon Abbott, Reginald Foster, Alexander Cochrane, Stillman F. Kelley and Walter Hunnewell.

Philadelphia:	*Closing.*
Electric Company of America	10¾
Electric Storage Battery common	79½
Electric Storage Battery preferred	79½
Philadelphia Electric	10½
Philadelphia Rapid Transit	16½
United Gas Improvement	105½

Electric Storage Battery directors have declared the regular quarterly dividends of 1¼ per cent on both the common and preferred stocks, payable January 2.

Chicago:	*Closing.*
Chicago Telephone	144
Chicago Edison Light	170
Metropolitan Elevated preferred	65
National Carbon common	44¾
National Carbon preferred	109¾
Union Traction common	9
Union Traction preferred	38

The report of the auditor of the Union Taction Company for the year ended September 30, 1904, shows an operating deficit of $13,338, and a decrease of $2,637,294 in total assets.

NEW INCORPORATIONS.

BENTLEY, KAN.—People's Telephone Company. $1,500.

BEVERLY, KAN.—Beverly Telephone Company. $3,000.

KIRWIN, KAN.—The Mutual Telephone Company. $1,500.

WEBER, KAN.—The Weber Telephone Company. $5,000.

OXFORD, KAN.—Oxford Mutual Telephone Company. $3,000.

LEWIS, KAN.—Edwards County Telephone Company. $5,000.

WEBBERVILLE, MICH.—People's Telephone Company. $6,000.

MURPHY, N. C.—Murphy Electric Light and Power Company. $6,000.

BLUE RAPIDS, KAN.—Blue Rapids Telephone Company. $12,000.

SAN DIEGO, CAL.—United Light, Fuel and Power Company. $500,000.

PARALLEL, KAN.—Riley County Farmers' Telephone Company. $2,600.

CEDARVILLE, OHIO—Cedarville Telephone Company. Increased from $15,000 to $40,000.

PORTLAND, ME.—Amalgamated Wireless Securities Company. $10,000,000. Incorporators: M. W. Baldwin and G. C. Ricker.

MACKINAW, ILL.—Mackinaw Electric Light Company. $8,000. Incorporators: S. A. Thompson, George Tyrell and C. G. Sparks.

BELLEVILLE, ILL.—Ada Electric and Gas Company. $100,000. Incorporators: J. A. Hamilton, A. B. Daab and L. D. Turner, Jr.

BUFFALO, N. Y.—The Phelps Light Company. $50,000. Directors: William Hooker, Batavia; E. W. Phelps, W. E. Hooker, Buffalo.

ALEXIS, ILL.—Farmers' Mutual Telephone Exchange Company. $5,000. Incorporators: Allen Moore, Warren Bruington, and R. T. Shaw.

JERSEY CITY, N. J.—North Jersey Electric Light, Heat and Power Company. $500,000. Incorporators: Benjamin F. Treacy, F. J. Smith and John O'Reagan.

NEWARK, N. J.—Middlesex Lighting Company. $100,000. Incorporators: Albert B. Carlton, Elizabeth; Percy S. Young, Passaic; Frederick Evans, New York city.

FLUSHING, OHIO—Stillwater & Wheeling Valley Traction Company. $5,000. Incorporators: J. A. Hobson, V. N. Marsh, R. D. Judkins, E. L. Hobson and A. B. Hobson.

FAIRMONT, W. VA.—The West Fork Belt Line Railway Company. $100,000. Incorporators: J. M. Jacobs, C. H. Jenkins, Wilbur Griffin, J. M. Brownfield and Harry Shaw, all of Fairmont.

JERSEY CITY, N. J.—The Michigan Light Company; to construct and operate heating and lighting plants. $2,250,000. Incorporators: Walter B. Mahoney, Walter Thiele and Charles N. King, all of Jersey City.

FAYETTEVILLE, W. VA.—The Beckley Electric Light and Power Company. $25,000. Incorporators: J. J. Duffy, Lewisburg; John W. McCreary, Thomas H. Wickham, Thomas H. Laing and Ashton File, of Beckley.

JERSEY CITY, N. J.—The Selection Telephone Company has been incorporated with $200,000 capital. The incorporators are Le Roy S. Lewis, Hartford, Ct.; Joseph R. Carroll, East Hartford, Ct., and John J. Mara, Jersey City, N. J.

EGLON, W. VA.—Eglon Mutual Telephone Company; to construct and operate a telephone system in Preston County. $5,000. Incorporators: Adolphus R. Fife, Charleston Shank, L. Lloyd Dawson, James Fike, Herman H. Beckman, of Eglon.

BALLSTON, N. Y.—Eastern New York Railroad Company; to operate an electric road ten miles long from Ballston to Middle Grove. $100,000. Directors: F. F. Barrett, Saratoga; Fred A. Beach, B. S. Cole, Ballston; T. R. Heller, Somerton.

ST. PAUL, MINN.—Hutchinson & Western Railway Company; to construct a railway westerly through the counties of McLeod, Meeker and Kandiyohi. $50,000. Incorporators: Edward L. McGrory, William E. Ellis, Cyrus A. White, Edgar H. Bass, Cyril C. White and Hugh M. Funson.

ELECTRIC LIGHTING.

IRVINGTON, N. J.—A lighting plant is to be established at Olympia Park.

MEMPHIS, TENN.—S. C. Dowell, of Walnut Ridge, will establish an electric light plant at Pocahontas, Ark.

RUSSELVILLE, ARK.—R. Smith and a number of citizens of this place have purchased the electric light plant.

ELDORADO, KAN.—A franchise to erect an electric light plant has been granted by the city council to W. Martin Jones.

TARBORO, N. C.—The power-house of the electric light plant owned by the town was destroyed by fire recently. The loss is estimated at $3,000.

CHATTANOOGA, TENN.—A company with a capital of $6,000 has filed articles of incorporation, and will give the town of Obion electric lights.

SIOUX CITY, IOWA—Edward Tilden and Samuel McRoberts, of Chicago, are having plans prepared for a lighting, power and heating plant which they will install.

ST. JOSEPH, MO.—The board of public works has awarded the contract for electric lighting machinery to the General Electric Company, of Schenectady, N. Y., for $29,712.

MUNCIE, IND.—The Muncie Electric Light Company has been awarded the contract for the lighting of Riverside for a period of five years by the committee of the town board.

BURLINGTON, VT.—The contract for furnishing current for the electric system to be installed at Fort Ethan Allen has been awarded to the Burlington Light and Power Company.

BATAVIA, N. Y.—The village board of trustees has authorized a contract with an electrical company to replace all of the electric lights in the village with enclosed arc lamps at a cost of $2,375.

TORONTO, ONTARIO—The Electrical Development Company has awarded contracts aggregating about $120,000 for a new subsidiary power station, and has plans ready for a new power-house to cost $30,000.

NEW CASTLE, DEL.—The city council has decided to give the exclusive right to furnish water and light to the residents of this city, for a period of twenty-five years, to the Delaware Water Improvement Company.

ST. JOSEPH, MO.—The board of public works has awarded to the Minneapolis Steel and Machinery Company the contract for installing one of its 520-horse-power Corliss engines in the new city electric lighting plant.

SEATTLE, WASH.—The municipal lighting plant on Cedar river has been put into actual operation and is now running steadily day and night, supplying 1,000 horse-power current to the Snoqualmie Light and Power Company.

ST. LOUIS, MO.—A building permit has been granted the Union Electric Light and Power Company for the erection of a substation to cost $26,000. Excavations are now nearly completed for another building to be used for the same purpose.

JELLICO, TENN.—The Jellico Electric Light, Heat and Power Company has decided to increase the capacity of its plant, and at a recent meeting funds were appropriated for this purpose. A 250-horse-power engine will be put in.

PASSAIC, N. J.—Thomas Foxhall has made arrangements to build a lighting plant to cost over $50,000 on the lots adjoining the old lighting plant on the Erie railroad near Highland avenue. The building alone will cost the amount stated.

CHICAGO, ILL.—The city council of Beardstown has accepted the proposition of the electric light company to furnish sixty-five street lights, one arc light in City park and incandescent lights in the city buildings. The contract is for five years.

REARDON, WASH.—J. M. McDowell, of Deer Park, has made application for a franchise to establish and operate an electric lighting plant in Reardon. An ordinance has been introduced

granting a fifteen-year franchise to light the town. The ordinance can not, however, be finally passed, until the next regular meeting in January. Mr. McDowell will order the machinery at once, and expects to have the plant in operation by March 1.

MONROE, MICH.—Ground was broken recently for an electric lighting plant for the new St. Mary's Academy building, now being erected in this city. The power-house will be 150 by 50 feet, with the most modern equipment, and will cost $60,000.

PORTLAND, IND.—The city of Portland has made a new five-year contract with the F. Bimel company for power for the electric light plant. The Bimel company has been furnishing the power for the plant since it was bought by the city ten years ago.

DAYTON, OHIO—The Dayton Electric Light Company has sold $500,000 worth of its stock to eastern capitalists for the purpose of securing money to place the uptown wires underground and make other improvements. The present management will remain in control.

KEARNY, N. J.—The engineers appointed to estimate on a municipal lighting plant report that such a plant could be installed for from $47,500 to $55,000. The estimated cost of operation is from $9,000 to $11,000, a saving to the town of from $5,000 to $7,000 annually.

AMERICAN FORK, UTAH—The auxiliary electric light and power plant which the Utah County Light and Power Company, of this place, is arranging to install one and one-half miles above its present plant, in the American Fork cañon, will, it is estimated, cost about $150,000.

SEDALIA, MO.—The people of Sedalia have voted to grant the consolidated gas and electric companies a ten-year contract to light Sedalia. Horace Rumsey and Joseph Clarke, of St. Louis, are at the head of the new company, with L. P. Andrews, of this city, as general manager.

HARTFORD, CT.—A certificate of organization of the American Motive Power Company, of New Haven, has been filed with the secretary of state. Two hundred and eighty-three shares of capital stock have been subscribed, which have been paid for in property valued at $28,300.

LAMBERTVILLE, N. J.—The Lambertville Heat, Light and Power Company has entirely remodeled the electric plant in that city. Two new dynamos and a new engine have been installed, part of the city has been rewired, a day circuit will be used and electricity furnished to New Hope.

CHARLOTTE, N. C.—The Factory Site and Power Company, which was incorporated at Waynesville lately with a capital of $300,000, will have 500 horse-power ready for transmission by January 1, and 1,500 horse-power early in the year for the use of cotton mills and other factories in its neighborhood.

DEADWOOD, S. D.—The new electric light plant at Spearfish is in operation. Power is furnished by water from the Spearfish river, but a steam power plant has also been installed as an auxiliary and for use in emergencies. It is stated that the new plant has been completed at a cost of nearly $50,000.

NEW BRUNSWICK, N. J.—The Light, Heat and Power Company held its annual meeting recently, at which the old directors were reelected, as were the old officers of the company. The officers are: president, John C. Eisele; treasurer, Nathaniel King; secretary, Henry M. Barrett. All reside in Newark.

READING, PA.—The Birdsboro Electric Company at its annual meeting elected the following: George Brooke, president; William Lincoln, secretary and treasurer, and these directors; George Brooke, Jr., Robert E. Brooke, Harry K. Harrison, John Sponagle, I. F. March, William Lincoln and George W. Lacey.

PITTSBURG, PA.—The Duquesne Light Company, which recently obtained a franchise from Pittsburg councils, is planning to extend an electric lighting system to many parts of the country. Applications have been made for charters for the Tube City Light Company, the Colonial Light Company and the Home Light Company, the first located in McKeesport, the second in Braddock and the third in Homestead. The incorporators of the three companies are J. G. Splane, Shirley P. Austin and George K. Anderson. These companies are in reality parts and extensions of the Duquesne Light Company.

DAVENPORT, IOWA—The People's Power Company has increased its capitalization from $600,000 to $1,000,000, and has decided on further improvements to its property in the coming year. During the past year there was an expenditure of $150,000 on improvements and extensions. The increase was voted at the last meeting of the directors.

WILKESBARRE, PA.—The construction of a large electric plant will soon be begun at Butzbach's. The plant will be used to furnish light and power in three of the mines of the Delaware, Lackawanna & Western Coal Company. The poles and wires are already placed as far as the Truesdale breaker and the others will be put up by the time the plant is ready for operation.

MONTREAL, QUEBEC—Edouard Beaudry has entered into full control of the electric light plant at St. Johns, Quebec. The town council of St. Johns has granted Mr. Beaudry a ten-year contract for the lighting of the city. The power is furnished from a fall on the Yamaska river, a short distance from the town. The purchase price is said to be in the vicinity of $300,000.

MONTGOMERY, MINN.—S. A. Vopatek has obtained an exclusive franchise for an electric light plant. Mr. Vopatek is associated with J. E. Anderson, and will incorporate under the firm name of the Montgomery Electric Light Company. The franchise covers a period of twenty-five years, and gives the city the right to purchase the plant any time after the expiration of two years.

UKIAH, CAL.—At a special meeting it was agreed to enter into a contract with W. W. Van Arsdale, the owner of the Walker Valley ranch, to furnish the city of Ukiah with electric power. The city agreed to pay four dollars per month per horse-power, the power to be delivered at the switchboard in Ukiah. The contract is to run for ten years, and ten years more at the option of the town. The plant is to be ready for service by next September.

SPRINGFIELD, MASS.—The Central Massachusetts Electric Company held its annual meeting recently, when the following officers were elected: president, Charles E. Fish; vice-president, George C. Flynt; manager, A. J. Purenton; treasurer, Charles B. Fiske; clerk, A. J. Purenton; directors, G. E. Fuller, George C. Flynt, Charles E. Fish, A. J. Purenton, Charles B. Fiske, W. H. Fairbank, A. W. Paige, Charles F. Grannis and Edward Fairbanks. The company's statement shows a surplus of $14,130.01.

BELLAIRE, OHIO—The contract for the lighting of the streets by electricity was awarded by the Board of Public Service to the Bellaire Light and Power Company, it being the only bidder. The bids were asked for periods of three, five and ten years, separate bids to be made for each period. The above company's bids were $80, $75 and $70 respectively for the three periods and it was given the contract for ten years at $70 per light. The contract also specifies that the city is to receive the same free light as in the former contract for the park and public buildings.

NORTH CANAAN, CT.—The Berkshire Power Company, of this place, has filed a certificate of incorporation with the Secretary of State. The capital stock is $204,000, of which $400,000 represents preferred shares and $200,000 common shares. The incorporators are Walter S. Morton and Arthur D. Newton, of Hartford, and J. Henry Roraback, of North Canaan. Under the terms of its incorporation the company has wide power for the development of power privileges in order to generate electricity. The concern is forming ambitious plans for the development and distribution of electric power.

GREENVILLE, S. C.—The Belton Power Company, located in Greenville County, and with a working capital of $350,000, is making rapid progress with the construction of the dam and electric plant on the Saluda river at Holliday's Bridge. While work has been under way for some time the plant will not be in operation before June or July of next year. The company will also light and install waterworks in the towns of Williamston and Belton, contracts having already been signed. The company will develop the shoals on Saluda river from Cooley's bridge to Holliday's bridge and will create 5,000 horse-power from these waters.

TELEPHONE AND TELEGRAPH.

GOWRIE, IOWA—J. F. Nordin seeks a franchise for a telephone line.

NEWPORT, R. I.—Improvements have been made to the local exchange.

PAXVILLE, S. C.—The Sumter telephone line is being extended from here to Summerton.

EASTON, PA.—The Pennsylvania Telephone Company is rebuilding its line from Nazareth to Bath.

MILLCREEK VALLEY, KY.—A franchise has been granted to the Independent Telephone Company.

BOLTONVILLE, VT.—The Northeastern telephone line from Groton to Wells River is being rebuilt.

ALBANY, N. Y.—The Columbia Telephone Company is extending its lines from Elizaville to Pine Plains.

MILWAUKEE, WIS.—The Eastern Wisconsin Telephone Company is installing an exchange at Brillion.

MARIETTA, GA.—A new exchange equipment has been installed by the Bell Telephone Company at a cost of $15,000.

WALDO, ME.—It is understood that the China Telephone Company is to extend its lines to Liberty and Cooper's Mills in the spring.

LYNCHBURG, VA.—The Southern Bell Telephone Company has completed an additional long-distance circuit between Lynchburg and Danville.

ATHENS, PA.—A new telephone line is being put up from Troy, *via* Leona, Springfield and Big Pond. A branch line is to run from Leona to Wetona.

SAN DUNE, CAL.—The Sunset Telephone Company is preparing for the installation of about a thousand feet of underground conduits at Venice.

ELLERY, N. Y.—At the annual meeting of the shareholders of the telephone line to Sinclairville it was voted to extend the line to Towerville.

PENDLETONVILLE, TEX.—J. W. Moore and son have bought the Pendleton Telephone Company, and will put up lines along the various public roads.

SAN DIEGO, CAL.—C. W. Bigelow, of Redlands, Cal., is contemplating running a telephone line into the valley, by way of Banning and Coachella.

BEATRICE, NEB.—The Independent Telephone Company is making plans to build another telephone line southwest of Blue Springs as soon as possible.

GALVESTON, TEX.—A construction gang is stringing about 50,000 feet of lead cables for the Southwestern Telegraph and Telephone Company in Galveston.

AKRON, OHIO—The Bell Telephone Company will extend its line from Akron to Northwest Newstead. A large number of farmers have signed contracts for a year's service.

YOUNGSTOWN, OHIO—The Mahoning Valley Street Railway Company has closed a contract with the Central Union Telephone Company for the installation of a private branch telephone exchange.

ORWELL, VT.—The Cooperative Telephone Company is extending its lines to Orwell, where they will connect with the People's line at Brandon. It is also building to Ticonderoga by way of Mount Independence.

SALAMANCA, N. Y.—A. V. Hunt, of Olean, has purchased the Home Telephone Company, of Port Alleghany. He will extend the wires to Smithport and Coudersport, where they will connect with the Inter-Ocean lines.

KANSAS CITY, MO.—Sixty farmers have organized a new telephone company and will build thirty miles of line from Higginsville to Salem, in Johnson County. Branches will extend to Aullville, Concordia and Mayview.

PRINCEVILLE, ILL.—The Keck Telephone Company, a local system, is now connected with the Bell long-distance line, giving communication with all points in the state, as well as the principal cities in the United States.

FULLERTON, CAL.—The Home Telephone Company has commenced the construction of its long-distance line from Buena Park to Fullerton, a distance of four miles. It will touch the main Los Angeles-Santa Ana line.

BATTLE CREEK, MICH.—The Michigan State Telephone Company has completed a rural line from Battle Creek to Climax, twelve miles distant. The company is also constructing a line from Battle Creek to Assyria, Lacey and Dowling, in Parry County.

SEATTLE, WASH.—Plans for extensions that will cost $300,000, and which are the first steps toward running lines that will practically cover the entire Puget sound country, have been perfected by the Independent Telephone Company.

NEW HOLLAND, PA.—The Enterprise Telephone and Telegraph Company has started to build a line to Alert, Cambridge and South Hermitage. This will open up a territory which is at present without telephone service.

COVINGTON, LA.—It is announced that H. H. Smith, Paul Laborde and several other citizens of Covington will organize a telephone company and put in an up-to-date local exchange. They claim that this is necessary on account of the lack of accommodation afforded at present.

WICHITA, KAN.—The Whitewater Telephone Company has completed its line from Whitewater to Wichita. The line connects with the lines of the Wichita Independent Telephone Company at that point. The Whitewater line is a rural one, and has over two hundred subscribers.

CORDELE, GA.—The Bell Telephone Company is having estimates prepared for the installation of aerial cables throughout the business section of Cordele. When this work is finished the remodeling of the entire telephone system of the Bell company in Cordele will be completed.

OMAHA, NEB.—One hundred and sixty men are engaged in stringing new wires and putting in new telephones in Omaha for the Nebraska Telephone Company. About 1,500 new telephones secured on the reduced tariff that goes into effect for residences January 1 are to be installed.

LIBERTY, IND.—The Liberty telephone plant has changed hands, Joshua Davis, of Liberty, James Davis and several farmers in the vicinity buying the plant for $80,000. The Liberty Telephone Company was organized seven years ago, and its lines now cover almost the entire county.

MONROE, GA.—At a meeting of the Monroe Telephone Exchange Company, the Walton Telephone and Telegraph Company and the Monroe & Compton Telephone and Telegraph Company, a consolidation of all the companies resulted. The new organization will be styled the Monroe Telephone Company.

BINGHAMTON, N. Y.—The Oneonta Telephone Company, operating in and around Oneonta, N. Y., and the Bell Telephone Company have effected a consolidation of their interests, so that hereafter there will be but one telephone company operating in that city. By this arrangement something over 1,000 telephones are added to the Bell list.

MINNEAPOLIS, MINN.—Minneapolis capitalists, headed by S. S. Thorpe, have bought the Iowa properties of the Mississippi Valley Telephone Company for $400,000. Five exchanges, covering the Iowa cities of Burlington, Muscatine, Keokuk, Madison and Wapello, are taken over. New management will be installed, and extensions will follow.

HINT, MICH.—The Michigan State Telephone Company, formerly known as the Bell company, has closed negotiations with W. H. Taylor, of Clio, by which the company takes over the rural telephone system of thirty telephones, known as "the Taylor line." The subscribers on the latter line have been connected with the Michigan state exchange in Clio.

LINCOLN, NEB.—The Lincoln Telephone Company has elected the following officers: C. J. Bills, president; A. W. Field, vice-president; F. H. Woods, secretary; A. C. Faulkner, treasurer.

These officers, together with Simon Mayer, A. C. Ricketts, George J. Woods, John T. Dorgan and Mark Woods, comprise the board of directors. The executive committee comprises F. H. Woods, chairman; C. J. Bills and A. O. Faulkner. The board created the office of general counsel and elected F. H. Woods to fill the position.

COHOES, N. Y.—At a meeting of the stockholders of the Cohoes & Waterford Home Telephone Company it was decided to increase the number of members of the board from eight to eleven, and P. H. Andrae, of Cohoes; F. H. Sudro and T. M. Brush, of Elyria, Ohio, were elected members of the board. It was also decided to put in additional cable in parts of the city.

SHEBOYGAN, WIS.—As a result of a conference between the officials of the Citizens' Telephone Company and the Wisconsin Telephone Company, the latter concern has agreed to leave the field in Sheboygan and Sheboygan Falls, and turn over its local service to the Citizens' company. The Wisconsin company's long-distance system will be connected with the Citizens' exchange.

MIAMI, FLA.—The Miami Telephone Company has been organized and the stockholders have elected the following officers to serve for the coming year: Glenn C. Frissell, president; Harry C. McCown, secretary and treasurer; directors, Glenn C. Frissell, Edward C. Romfh, A. P. Anthony, Harry C. McCown, Glenn C. Strohm, James T. Sanders and James R. Anthony, Jr. The new company will proceed at once to rebuild the entire line.

SANTA ANA, CAL.—The Smeltzer Home Telephone and Telegraph Company held its annual meeting recently, at which the following board of directors was elected: J. B. Lossing, president; H. J. Phelps, vice-president; C. C. Johnson, secretary; Bank of Huntington Beach, treasurer; G. W. Moore and J. T. Shaffer. While the company has been organized for some time it is not yet doing business. Poles are up and wires will be strung very soon, and it is expected the system will be in operation shortly.

COLUMBUS, OHIO—Work on the new telephone circuit from Columbus to Toledo for the United States Telephone Company has been completed as far as Marysville. From Columbus to Marysville a new cross-arm is being added to the United States company's poles, but north of that point there is a space on the present arms sufficient to accommodate the new Columbus-Toledo circuit. In addition a new circuit is being built from Columbus to Plain City and Marysville, it is said, will have an additional line into Columbus.

KINGSTON, ONTARIO—An agreement for an exclusive franchise for five years has been reached between the city council and the Bell Telephone Company. The city is to receive $700 per year, free use of the poles for fire-alarm wires, telephones to citizens at thirty dollars for business and twenty-five dollars for residences, two-party lines for residences at eighteen dollars each, and four at fifteen dollars. The company also agrees to erect a fine office building on Clarence street and install metallic lines with the most approved instruments.

PIERRE, S. D.—Articles of incorporation have been filed for the South Dakota Telephone Company with headquarters at Pierre, and a capital of $100,000. The incorporators are A. Ewart, E. P. Farr and W. S. Rowe, of Pierre, and G. E. Sumner and C. L. Millette, of Fort Pierre. The intent of the company is the construction of a telephone line from Pierre to the Black Hills, with branch lines to main points in the section of country between the river and the hills. The preliminary arrangements are already under way, and all the material will be on the ground in the spring. The line is to be a copper metallic circuit.

HUNTINGTON, TENN.—A new telephone company has been organized in some of the lower counties with a capital stock of $50,000. It will be known as the Consolidated Telephone and Telegraph Company, and is made up of the Sloan Telephone Company, of Linden; the Savannah Telephone Company, the Clifton company and the Tennessee River Telephone Company. The incorporators are J. K. Barlow and T. S. Hughes, of Savannah; H. B. Stubblefield, of Denson, and W. N. Sloan, of Linden. W. N. Sloan is president and manager; T. S. Hughes, vice-president; J. F. Barlow, secretary, and J. K. Barlow, treasurer. The company will operate lines in Perry, Lewis, Decatur, Wayne, Hardin and McNairy counties. Lines will also be run to Corinth, Miss., and to Florence, Ala.

NEW COMPANIES.

COLUMBUS, OHIO—The Safety Trolley Company, of Springfield, has been incorporated with a capital of $10,000.

NEW YORK, N. Y.—The National Gas and Electric Fixture Company, with a capital of $2,000, has been incorporated. The directors are Louis Doushkess, Paul Gillen, Abraham Levy, New York city.

PORTLAND, ME.—The Constant Park Plug Company has been incorporated to manufacture electrical apparatus. The capital is $50,000, and the following are the officers: president, H. L. Cram, Portland; treasurer, Charles H. Weston, Boston.

VINELAND, N. J.—The Daggett Trolley Company has been incorporated to manufacture and sell trolley improvements known as "the Daggett trolley." The incorporators are L. E. Heinly, of Chicago, and W. E. Daggett, and the capital stock is $50,000.

INDUSTRIAL ITEMS.

THE MARINETTE GAS ENGINE COMPANY is distributing a catalogue describing the Walrath gas engine, which is manufactured by this company.

THE YOST ELECTRIC MANUFACTURING COMPANY, Toledo, Ohio, is calling attention to Yost specialties in a neat catalogue which will be sent upon request.

THE HANCOCK INSPIRATOR COMPANY, New York city, is sending out a catalogue describing the Hancock globe, angle, sixty-degree, and cross-valves. The pamphlet contains twenty-three pages.

THE PITTSBURGH TRANSFORMER COMPANY, Pittsburgh, Pa., is distributing a pretty January, 1905, calendar. There is also a bulletin descriptive of apparatus and method of thawing frozen water pipes.

THE STANDARD WELDING COMPANY, Cleveland, Ohio, is distributing an attractive booklet entitled "What I Learned." This is an illustrated monologue concerning the educational features of a trip to the standard Welding Company's plant.

THE STANDARD ELECTRICAL MANUFACTURING COMPANY, Niles, Ohio, is calling attention to its line of incandescent electric lamps. The company has recently issued a number of attractive pamphlets, any of which may be secured upon request.

THE HOLOPHANE GLASS COMPANY, New York and Chicago, has issued two handsome folders entitled, respectively, "Light *versus* Illumination" and "Lighting of the Home." A booklet is also being distributed bearing the title "Scientific Illumination." This literature is worth going to some trouble to secure.

THE PHOENIX IRON WORKS COMPANY, Meadville, Pa., has received notice from St. Louis that the international Philippine jury of the exposition, in its capacity of associate of the board of exposition, has awarded a gold medal for the compound engine exhibited by this company in the power plant of the Philippine government board.

THE PRINDLE PUMP AND ENGINEERING COMPANY, 95 Liberty street, New York city, is distributing catalogue A, descriptive of Prindle standard house-tank pumps. The pumps are of the centrifugal type, and are driven by electric motors, either of the alternating-current or direct-current variety, the pump and motor being mounted upon the same base.

THE WILLIAMS ELECTRIC MACHINE COMPANY, Akron, Ohio, is sending out catalogue A, describing its electric clutch pulley and safety device, and electric hoists. The catalogue contains seventy pages, of which thirty-five are devoted to machinery, the balance of the booklet containing articles on mensuration, practical rules and tables, and information on gearing and belting.

PIRELLI & COMPANY, Milan, Italy, are presenting to their clients and friends the text of a paper read before the International Electrical Congress, St. Louis, Mo., September 13, 1904, by their chief electrician, Inz. E. Jona, on "Insulating Materials in High-

Tension Cables." The paper is presented in book form, in the original English text as delivered at the congress, and also the Italian translation. Pirelli & Company announce that their goods obtained at the St. Louis World's Fair a grand prize in the group of india-rubber goods in general, and two gold medals for insulated wires and cables.

THE BRACKETT BRIDGE COMPANY, Cincinnati, Ohio, is the designer and manufacturer of the new Highway bridge across the Miami river, at Elizabethtown, Ohio. This is believed to be the longest simple truss span in the world. It has a clear span of 568 feet. The bridge is being built by Hamilton County, Ohio, for which Mr. Frank Krug is county engineer. Mr. H. G. Tyrrell is chief engineer of the Brackett Bridge Company.

J. G. WHITE & COMPANY, 43 Exchange Place, New York city, has secured through its London branch a contract for equipping the traction system of Belfast, Ireland, with electricity. The system will comprise overhead and conduit construction, and the contract price is about $2,800,000. The company has also secured through its London branch a contract for electrifying the tramway system of Montevideo, Uruguay, at a contract price of $2,000,000.

PASS & SEYMOUR, INCORPORATED, Solvay, N. Y., is calling attention to the all-copper shell used in all of its Edison base sockets and receptacles. This is particularly important in sign receptacles or other installations where the device is subjected to exposure. The A. & W. Electric Sign Company, Cleveland, Ohio, announces that it has used sixty or seventy thousand of the P. & S. No. 1072, electric sign receptacles, and has experienced no trouble whatsoever with them.

J. P. HORNADAY & COMPANY, 1108 Traction Building, Cincinnati, Ohio, has reorganized a number of street railway, steam railway, waterworks, electric light and industrial propositions. This company, through its New York and Chicago connections, has outlets for its securities, which enables it to undertake the reorganization or promotion of any reasonable proposition. The company is now interested in several railway propositions in the South and Southwest.

THE VOUGHT-BERGER COMPANY, La Crosse, Wis., has issued a novel advertising folder in the form of a reply postal-card. The desirability of the pendant telephone for all purposes is set forth, and in addition to this there is a detailed description of the apparatus. On the reply half of the card is an order blank with prices of the various types of instruments. The card is to be used in sending for a trial instrument, subject to thirty days' time for demonstration as to its practicability.

THE STANDARD ROLLER BEARING COMPANY, Philadelphia, Pa., has purchased considerable new land fronting on the tracks of the Pennsylvania Railroad, for the increasing of its manufacturing facilities. A steel casting plant will be installed, and additions made to the foundry and to the factory for making steel balls. The company has only recently enlarged its plant by the building of a 250-foot addition to its machine shop, and an extension to the ball plant. Mr. S. S. Eveland, manager, is in charge of the improvements.

HENRY R. WORTHINGTON, 114 Liberty street, New York city, has issued a 132-page catalogue entitled "Pumping Machinery." The catalogue describes apparatus comprising the many types of pumping and condensing machinery and measuring devices which have been developed by this company within the last sixty-four years. The most prominent article described is the duplex steam pump and special designs of this pump adapted to boiler feeding, mine pumping, removal of air and circulating air for condensers, waterworks service and fire service. The book is printed in two colors, and the cover is lined.

THE GENERAL ELECTRIC COMPANY, Schenectady, N. Y., is distributing bulletins Nos. 4392, 4393, 4394, 4395 and 4396. No. 4392 describes the single-phase compensated motor equipment which is in operation on the Ballston division of the Schenectady Railroad. In addition to the equipment the track and line of this road are described. Bulletin No. 4393 describes small, moderate-speed, engine-driven, revolving-field alternators, No. 4394 taking up a new type of belt-driven alternator. No. 4395 is devoted to lightning arresters for direct-current circuits, and No. 4396 describes commercial types of searchlight projectors.

THE BISHOP GUTTA PERCHA COMPANY, 420-426 East Twenty-fifth street, New York city, is now adding a fourth story to its old factory building, which covers an area of seventy-five feet by ninety feet, which will be occupied by its gutta percha work and give it better facilities in this older building for turning out its electrical specialties. During the past year the company has erected a new four-story building, twenty-five feet by forty feet, doubling the area occupied by its office and laboratory and adding largely to its storage capacity. The company reports a good business in 1904, and anticipates a prosperous season in 1905.

THE BULLOCK ELECTRIC MANUFACTURING COMPANY, Cincinnati, Ohio, in buletin No. 1031 describes rotary converters. In addition to a number of half-tones showing various parts of the rotary converter in assembly, illustrations are given showing typical installations of this apparatus. The Bullock company is calling attention to its list of awards from the Louisiana Purchase Exposition. This includes a grand prize for the exhibit comprising Bullock alternating-current generators, sychronous motors, direct-current generators, direct-current motors and rotary converters; a gold medal for the multiple-voltage balancing sets for control of motors, and the grand prize for the "The Big Reliable," which included the 5,000-horse-power Allis-Chalmers engine and Bullock generator.

THE AUTOMATIC SAFETY STOP COMPANY OF AMERICA, 15-25 Whitehall street, New York city, is distributing a prospectus describing the patents for safety devices on railroads of which it is the owner. The company has recently been granted a patent on a simple and effective device which it is stated will overcome the difficulties hitherto encountered in allowing an engineer to run past a signal set against him, if the proceeding is made with caution. If the train is slowed down, the break-setting apparatus will remain inactive. It will, however, make a record that the signal has been overrun. Should the engineer fail to slow down, and for some reason neglect to obey the signal, the apparatus will set the brakes for him and establish a different record, which will have to be explained.

THE ABNER DOBLE COMPANY, San Francisco, Cal., has been awarded the grand prize for its exhibit of a 170-horse-power tangential water-wheel at St. Louis. The wheel develops 170 horsepower at a speed of 700 revolutions per minute, with a water pressure of 300 pounds per square inch, equivalent to a hydraulic head of nearly 700 feet. It is direct-connected to a 100-kilowatt railway generator, and is one of the units of the intramural power plant. The wheel is of the tangential type, with the Doble patented ellipsoidal buckets, and is provided with the Doble patented needle-regulating nozzle, operated by a governor. The sides of the wheel housing are made of plate glass, so that the action of the water on the wheel can be observed. The quantity of water delivered to the wheel is measured by a Venturi meter with automatic recording instruments, and the pressure of the water is registered by a recording gauge.

THE DEANE STEAM PUMP COMPANY, Holyoke, Mass., is distributing a new catalogue on condensers, No. D-23. This publication reviews the principles and advantages of the several types of condensers as applied to steam engines, including surface and jet condensers, and discusses, also, vacuum pumps, exhausters, air and circulating pumps, and other auxiliaries. A recent development, which is treated of quite fully, is the provision of proper condensing arrangements for steam turbines. Unlike the reciprocating engine the turbine can expand its steam to the extreme limit of the exhaust pressure and every inch of vacuum above twenty-six inches increases the economy by from three to five per cent. It is therefore advantageous to use the most perfect type of condensing equipment for this service, which has led to the production of improved types of independent air and hot-well pumps, separate circulating pumps, air coolers, etc,

ELECTRICAL REVIEW

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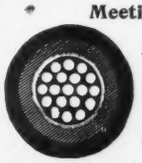
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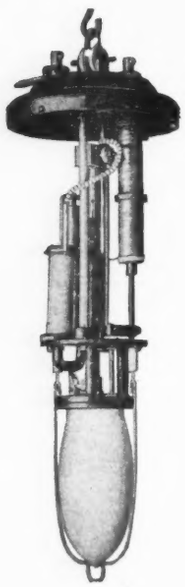

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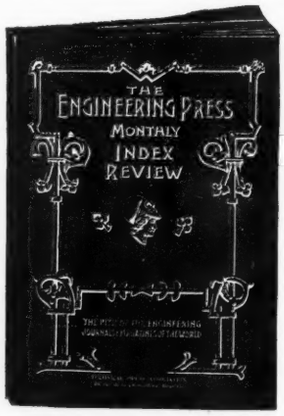

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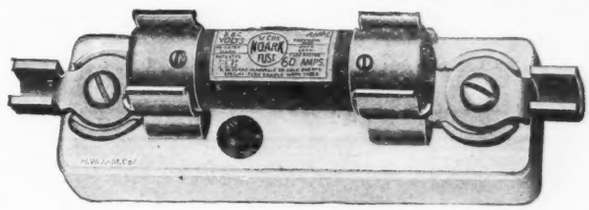

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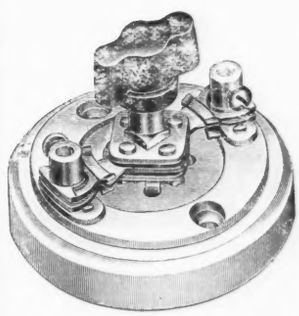

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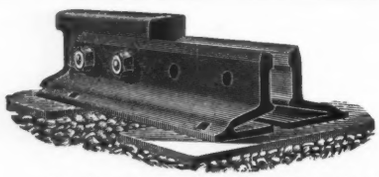

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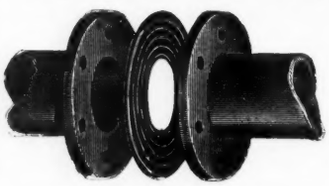

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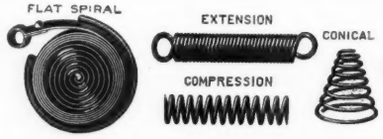

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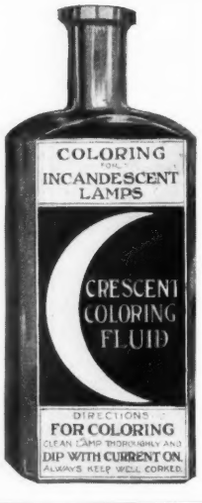

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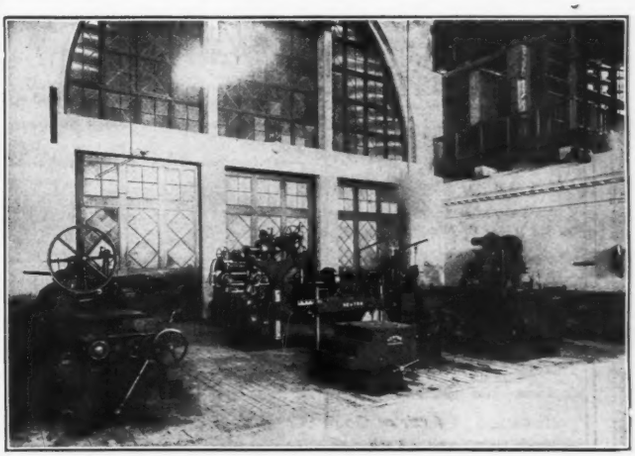

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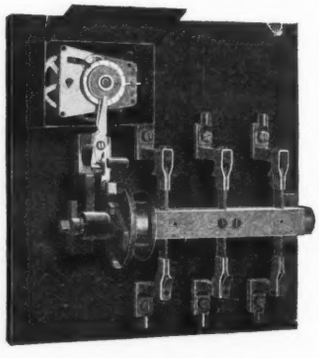

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January 14, 1905 (the twenty-third year of the *Electrical Review*), will be the date of a sumptuous *New Year's Number* of the *Electrical Review*, in which will be published an elaborate and brilliant series of articles showing the present status of Electrical Engineering and the accomplishments in the Electrical Arts.

These annual numbers of the *Electrical Review* form a permanent addition to the technical and scientific literature of the age.

The list of special contributors for this number comprises the names of many of the world's authorities in the various electrical branches.

As the work of preparation is carried on during the entire year, especial opportunities are developed for arranging the editorial features of this number well in advance so as to make the issue of interest in its reflections of the valuable advancement in ***all*** countries.

The articles will prove a succinct and a complete résumé of the progress and the important happenings of the year.

The illustrations in this number will be as numerous and as excellent in character as has ever been offered in a single issue of the *Electrical Review.*

In addition, the regular departments of news, industrial reviews, descriptions of new apparatus, etc., etc., will be fully covered in this number.

NUMBER of

January 14, 1905—Fourteen days after and after the season's distractions

Attractions to Advertisers in This Number

The circulation of the January 14, 1905, ***New Year's Number*** of the ***Electrical Review*** will exceed, we believe, that of any other electrical journal producing an edition of such elaborateness.

The demand for copies of the New Year's number in previous years was so great that the late orders were unfilled and this year agents and newsdealers are placing requisitions in advance.

In fact, orders have already been accepted for the sale, through special sources, of many thousands of extra copies.

As the issue will be the regular "Export and Domestic Number," the foreign circulation will be materially increased.

The advertising pages will be, in themselves, a splendid reflection of the status of the American Electrical Arts in all their multitudinous branches.

These pages will be made more than ordinarily attractive in typographical and artistic effect, and they are sure to be studied with unusual care because of their volume and completeness.

It is aimed to make the advertising a most interesting feature.

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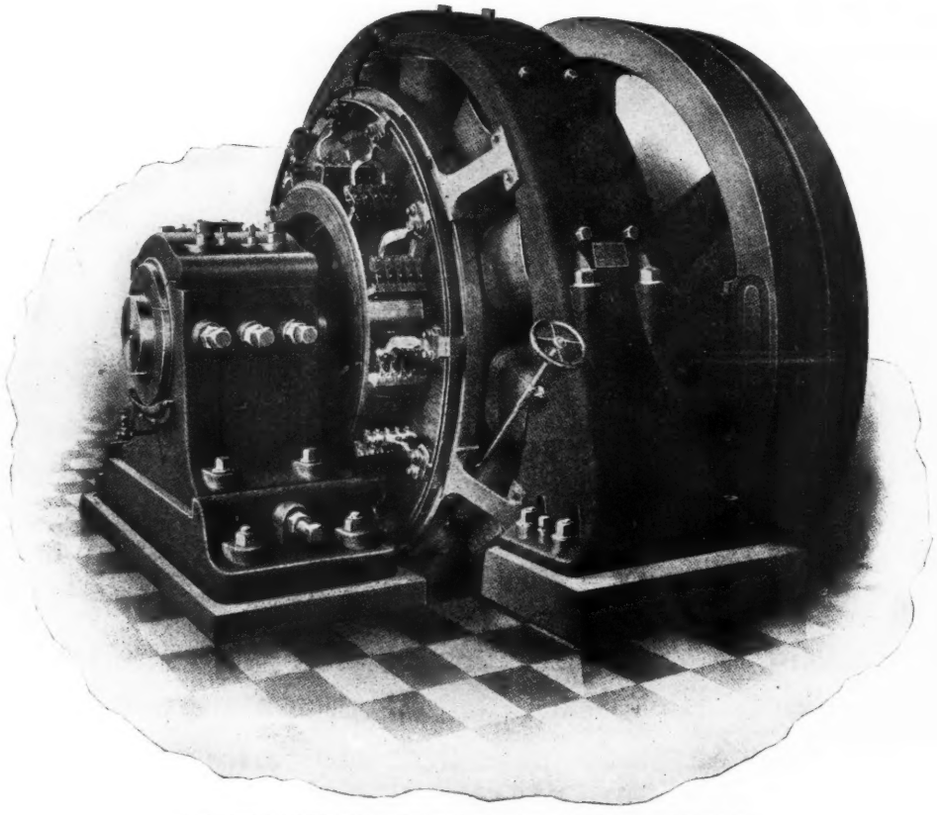

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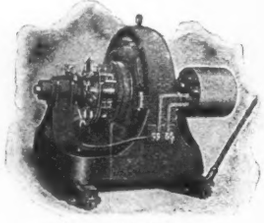

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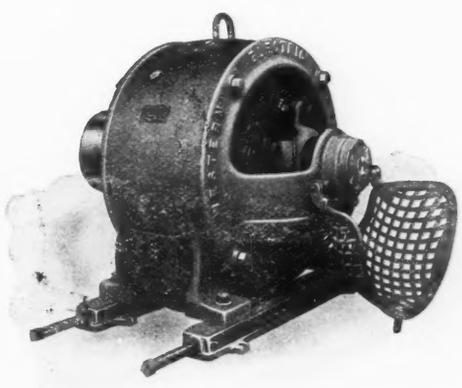

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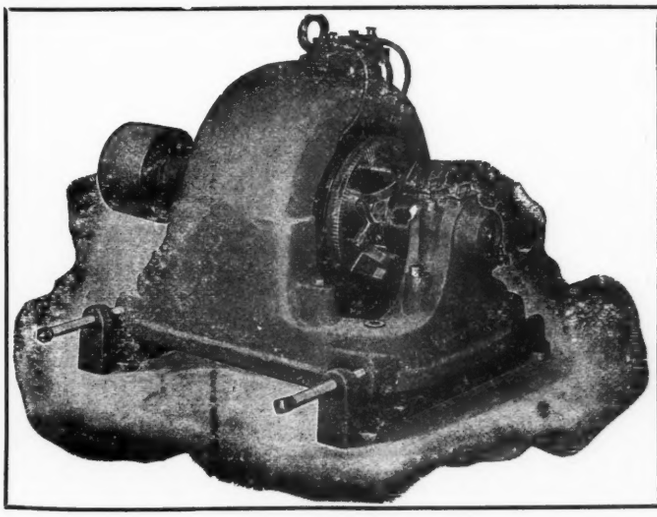

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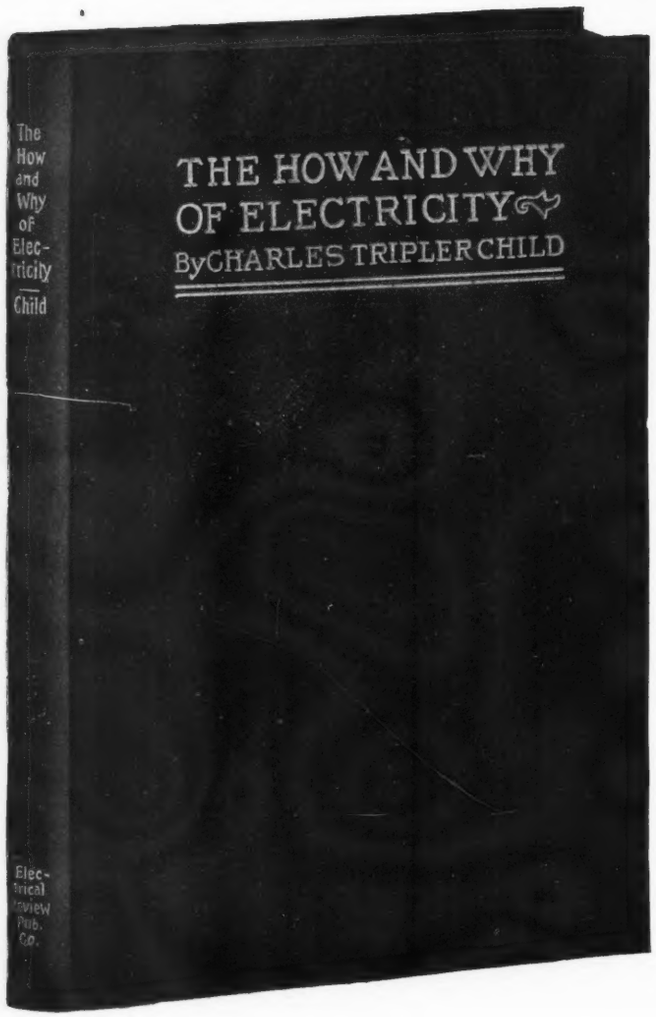

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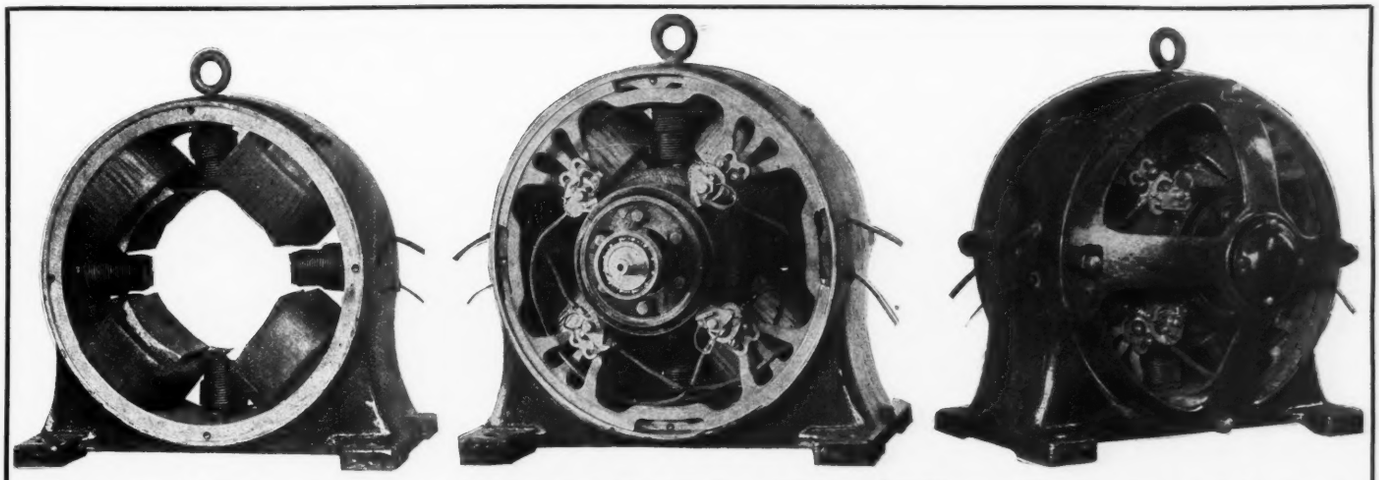

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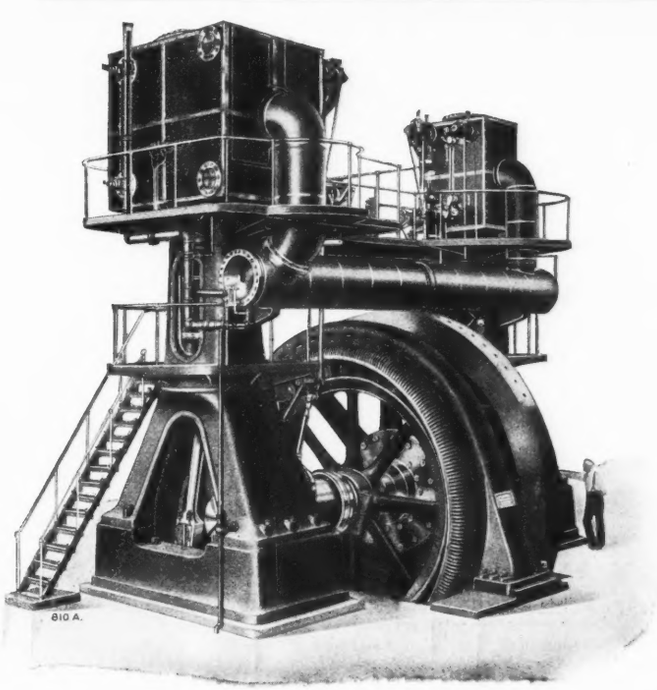

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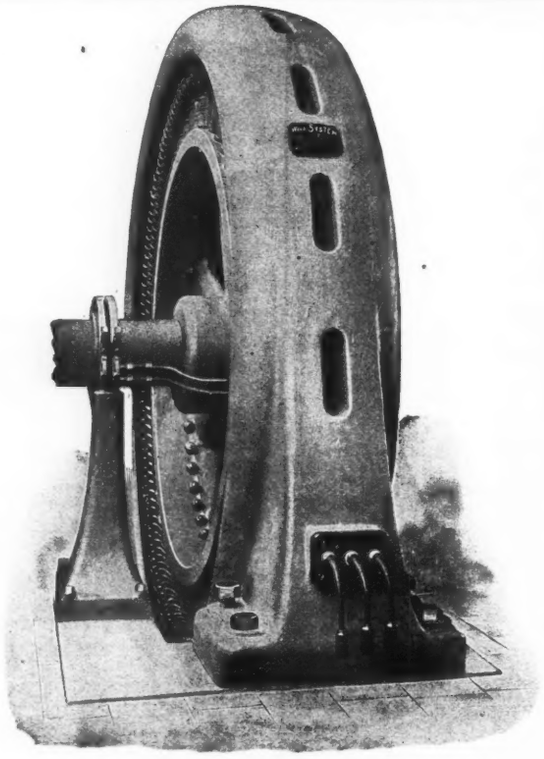

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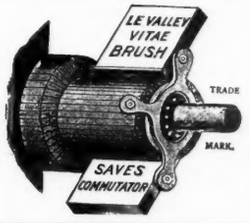

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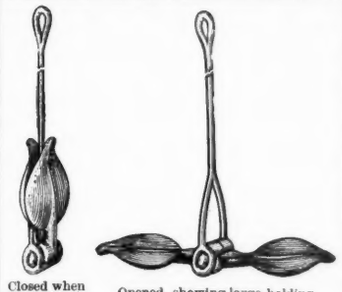

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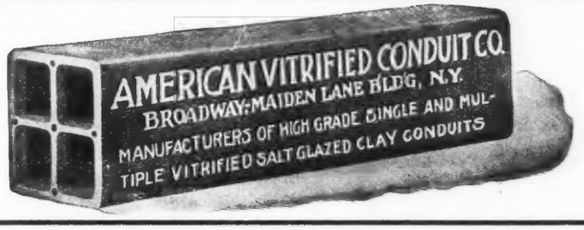
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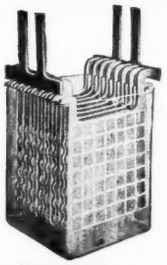

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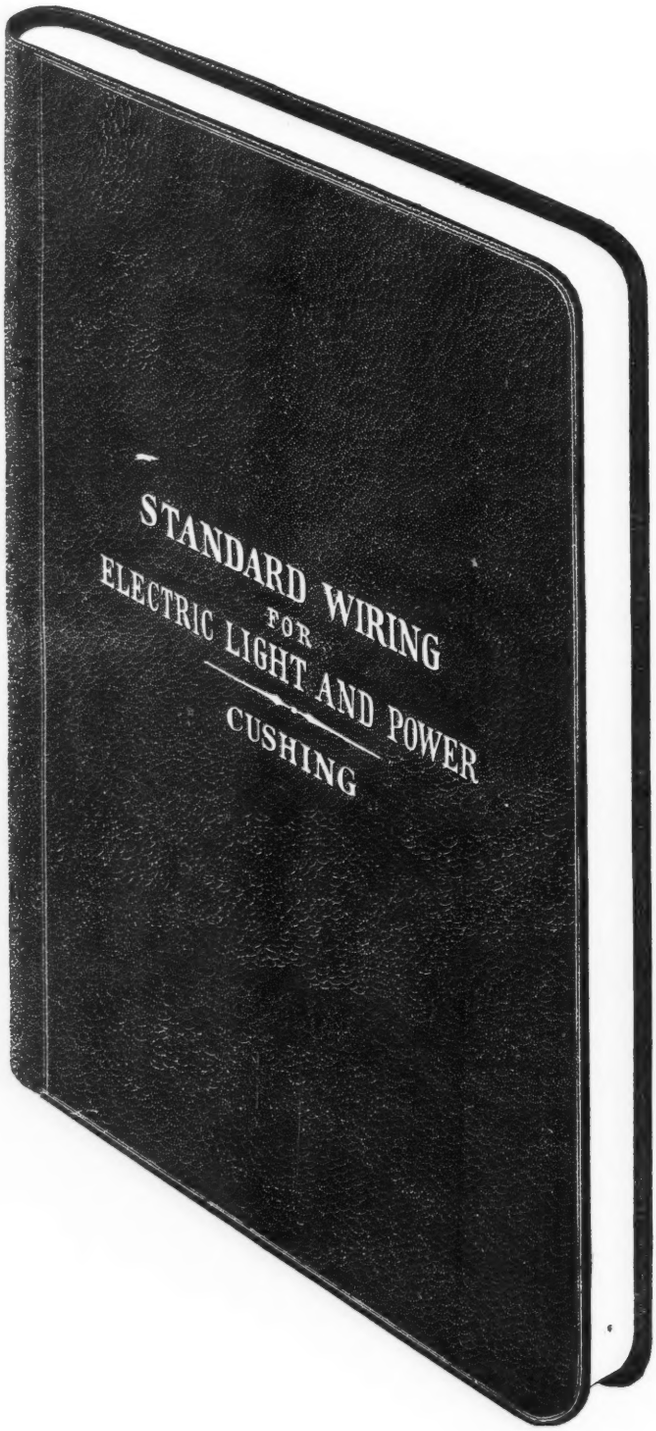

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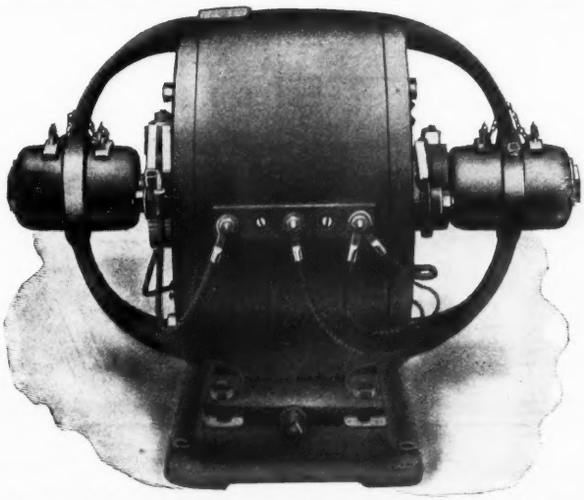

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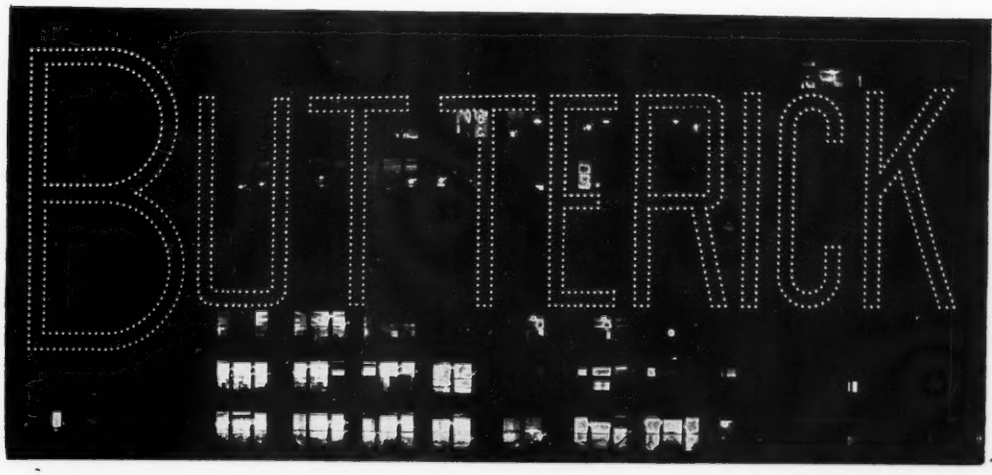

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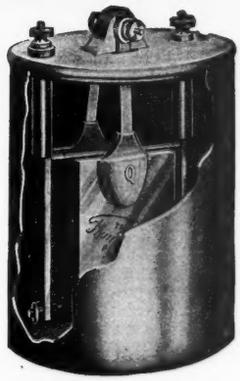

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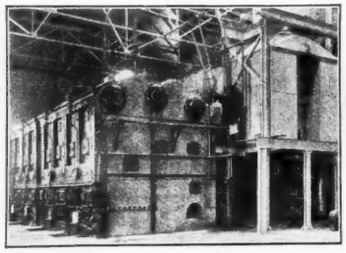

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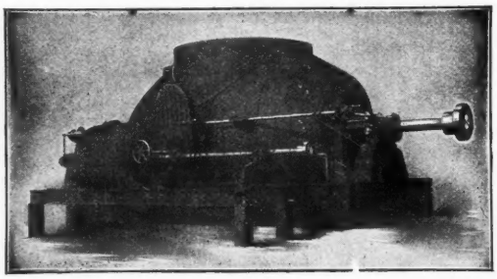

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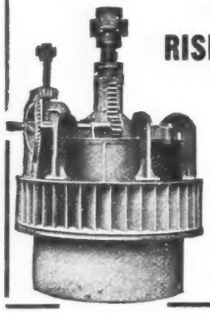

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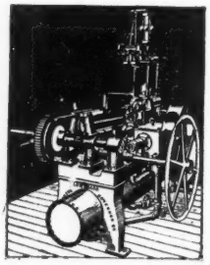

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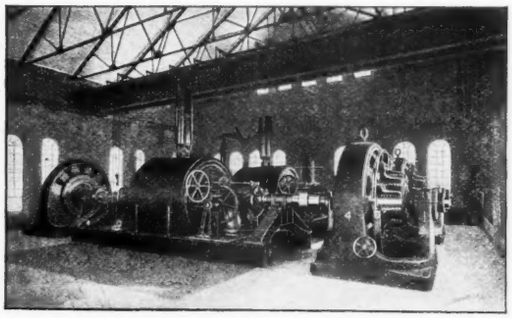

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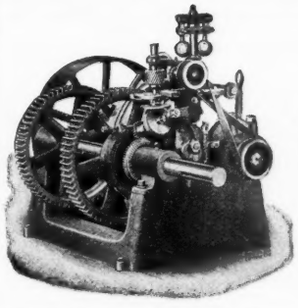

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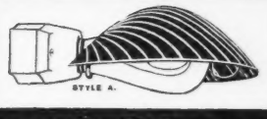

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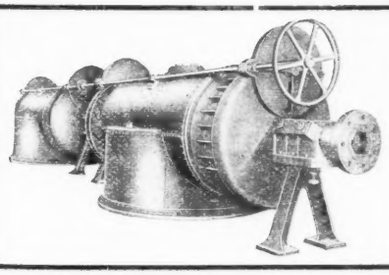

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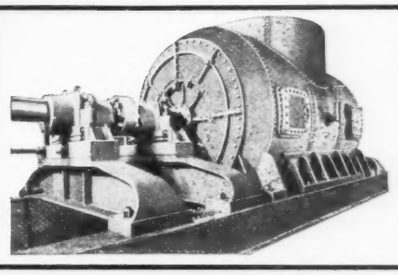

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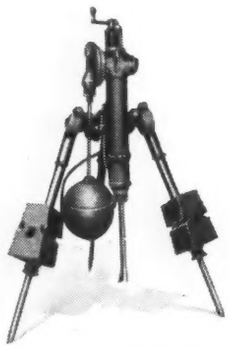

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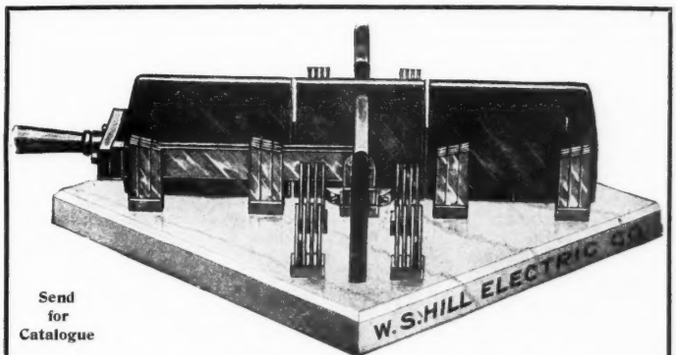

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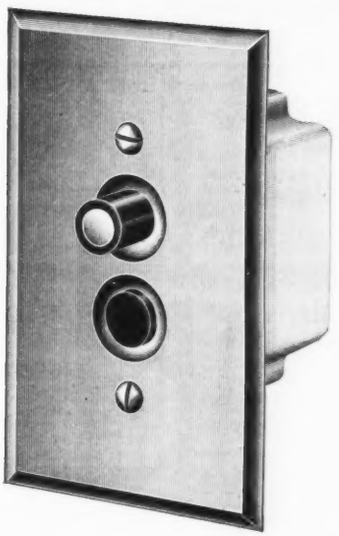

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American Electric Sign Co.
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H. T. Paiste Co.
Pass & Seymour, Inc.
Trumbull Electric Co.
Yost Electric Mfg. Co.

Soldering Sticks and Paste.
Allen & Co., L. B.
Burnley Battery & Mfg. Co.
Kester Electric Mfg. Co.

Spark Coils.
New York Coil Co.

Sparking Points.
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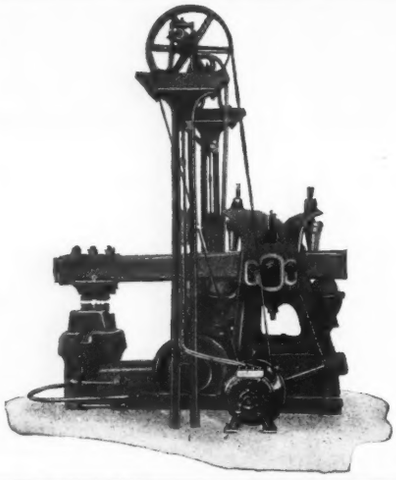

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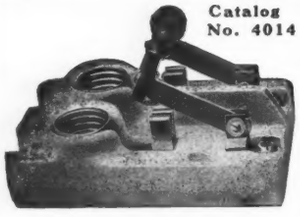

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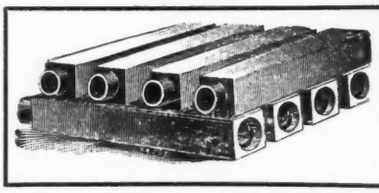

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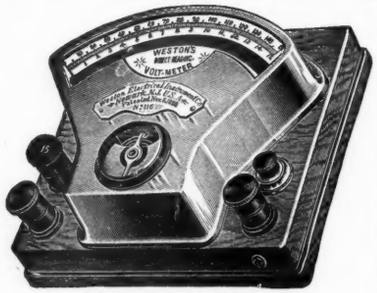

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New York Office, 74 Cortlandt Street.

List of Electrical Patents Issued Last Week

[Specially reported for this journal by E. S. Duvall, solicitor of patents, Loan and Trust Building, Washington, D. C. Copies of any patent may be secured for 10 cents each.]

ISSUED DECEMBER 20, 1904.

777,666 Cluster socket; J. H. Dale, New York, N. Y.

777,669 Process of producing salts of hydrosulphurous acid; A. Frank, Charlottenburg, Germany.

777,677 Automatic gas danger-signal; P. A. Kettering, Cadiz, Ohio.

777,691 Trolley head; E. V. Newcomb, Kansas City, Mo.

777,693 Electric locomotive; E. D. Priest, Schenectady, N. Y.

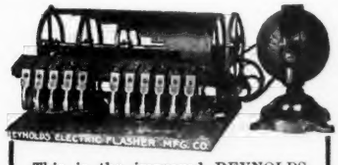
777,698 Trolley-head and wheel; J. W. Sharp, Mohawk, N. Y.

777,707 Insulated joint; G. A. Weber, New York, N. Y.

777,709 Brush-holder for dynamo-electric machines; E. Wœhr, Wilkinsburg, Pa.—Comprises a socketed frame, an extending arm, a toggle-joint hinged to the extending arm, a spring actuating the toggle-joint, a conductor-strip and a carbon grooved at the top.

777,741 Base for electric-lamp

(*Continued on page 48*)



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DOLEZALEK-VON ENDE—The Theory of the Lead Accumulator (Storage Battery). By DR. FRIEDRICH DOLEZALEK. Translated from the German with the Sanction of the Author by CARL L. VON ENDE, Ph.D. (Goettingen), Instructor in Chemistry, State University of Iowa. 12mo. xi+241 Pages, 30 Figures. Cloth, $2.50.

HANCHETT—Alternating Currents: Their Generation, Distribution, and Utilization. By GEORGE T. HANCHETT, M. E. 12mo. 180 Pages, profusely illustrated with line and half-tone cuts. Cloth, $1.00 net.

LE CHATELIER-BOUDOUARD-BURGESS—High-Temperature Measurements. By H. LE CHATELIER and O. BOUDOUARD. Translated by GEORGE K. BURGESS, Assistant Physicist at the National Bureau of Standards, Washington. Second Edition, Revised and Enlarged. 12mo. xiv+341 Pages. 79 Figures. Cloth, $3.00.

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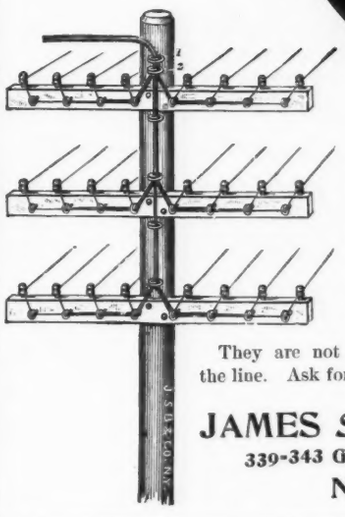

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bulbs; G. P. McDonnell, St. Louis, Mo.

777,750 Apparatus for indicating the magnetic condition of heating metals; G. W. Sargent, Reading, Pa.

777,759 Apparatus for automatically starting electromotors and regulating purposes; J. J. Thoresen, Bygdo, Norway.

777,760 Automatic signal system; J. R. Walsh, Boston, Mass.

777,764 Telephone-call register and time indicator; D. A. Yoder, Toledo, Ohio.

777,778 System for controlling electric motors; H. H. Cutler, Milwaukee, Wis.

777,801 Electric switch; W. J. Murray, Leavenworth, Kan.

777,807 Telephone system and apparatus; E. E. Ries, New York, N. Y.

777,808 Telephone transmitter; E. E. Ries, New York, N. Y.

777,833 Static electrical machine; C. F. Birtman, Chicago, Ill.

777,839 Motor starter; E. R. Carichoff, East Orange, N. J.

777,844 Meter; F. P. Cook, Lynn, Mass.—A dynamo-electric machine simultaneously supplying direct and alternating current to supply systems, and a single measuring instrument having a single indicating device for indicating the total output of the machine.

777,851 Electric battery; W. H. Gregory, Vallejo, Cal.

777,857 Dynamo for train lighting; J. F. McElroy, Albany, N. Y.

777,866 System of distribution; J. B. Taylor, Schenectady, N. Y.—Sections separately connected to the source or sources, and automatic switches adapted and arranged to connect said sections to each other when said sections are energized.

777,871 System of lighting hydrocarbon lamps; George Washington, New York, N. Y.

777,883 Control system; E. R. Carichoff, East Orange, N. J.

(*Continued on page 50.*)

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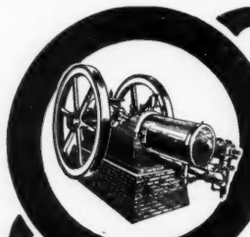
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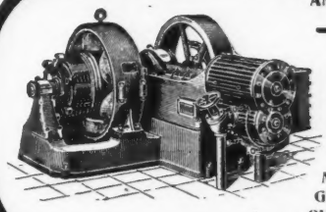

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777,912 Trolley-crossing; E. R. North, Webster Groves, Mo.

777,971 High-speed train system and apparatus therefor; T. H. Patenhall, Wilkinsburg, Pa.

777,972 High-speed permissive train system and apparatus therefor; T. H. Patenhall, Wilkinsburg, Pa.

777,974 Electromotive device for clocks; D. Perret, Neufchatel, Switzerland.

777,985 Battery; N. M. Watson, Detroit, Mich.

777,987 Apparatus for the treatment of gases; E. E. Werner, St. Louis, Mo.

777,988 Process of generating gases from air; E. E. Werner, St. Louis, Mo.

777,989 Apparatus for the treatment of gases; E. E. Werner, St. Louis, Mo.

777,990-991 Apparatus for treatment of gases; E. E. Werner, St. Louis, Mo.

778,005 Electric insulator; C. Booker, Toronto, Canada.

778,017 Trolley-guard; M. H. Dorsey, Woodlawn, Ala.

778,021 Electromagnetic apparatus for operating reciprocating mechanisms; J. Feingold, Frankfort, Germany.

778,037 Signaling mechanism; R. Herman, Crafton, Pa.

778,055 Electric switch; W. J. Lloyd, Pittsfield, Mass.

778,067 Telegraphic key; J. E. Pearson, Motor, N. C.

778,073 Elevator hoisting mechanism; H. Rowntree, Chicago, Ill.

778,101 Electricity meter; A. Blanchet, Paris, France.

778,120 Mutiplex telegraphy; T. B. Dixon, New York, N. Y.

778,146 Gas-engine ignition-dynamo; J. Reek, Camden, Mich.

778,155 Incandescent electric lamp and switch; G. Sweetser, Upper Norwood, England.

778,177 Telegraphy; T. B. Dixon, New York, N. Y.

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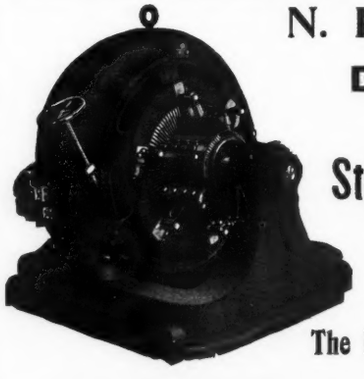

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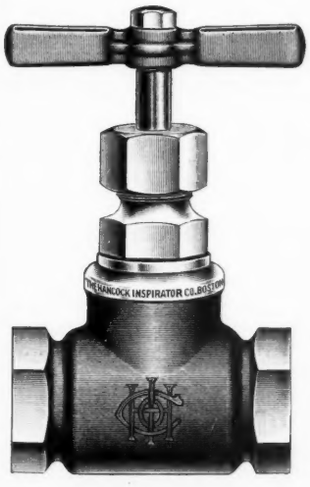

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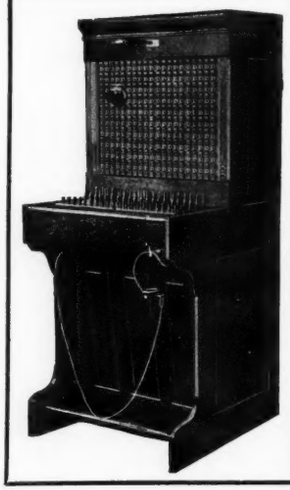

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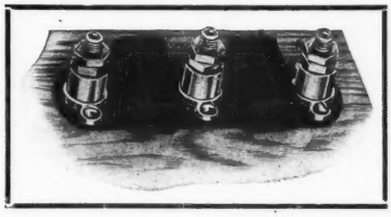
IT'S  NEW

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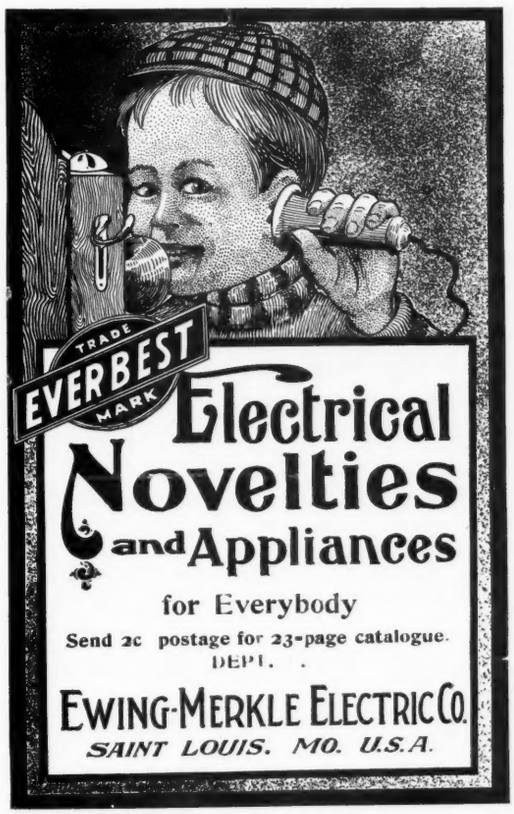

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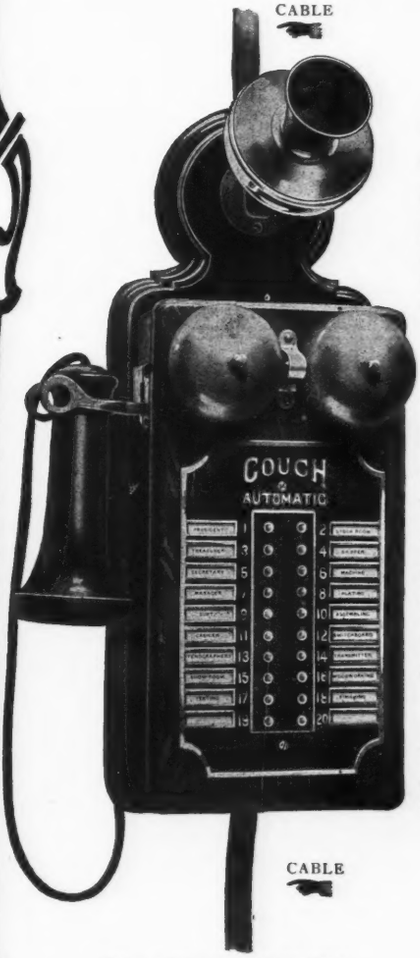

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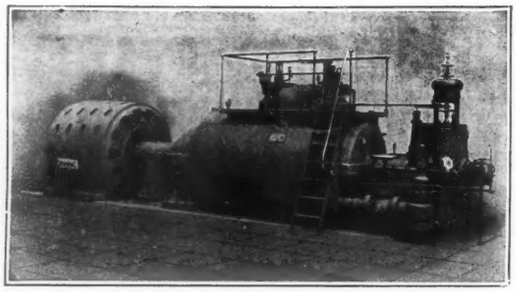

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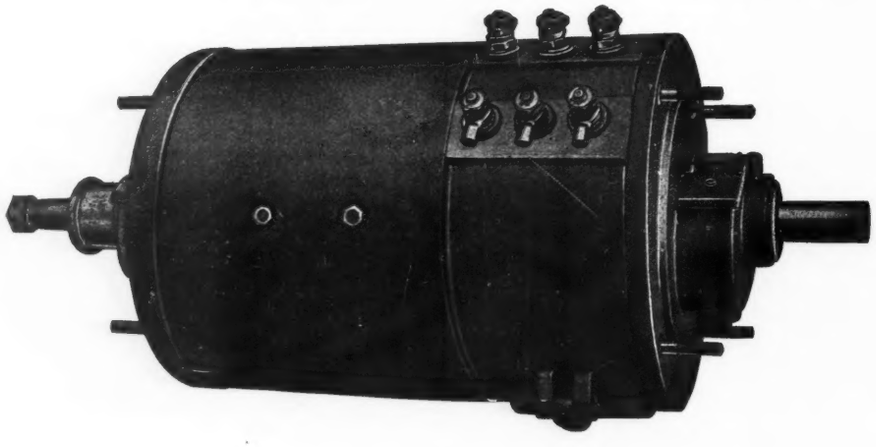

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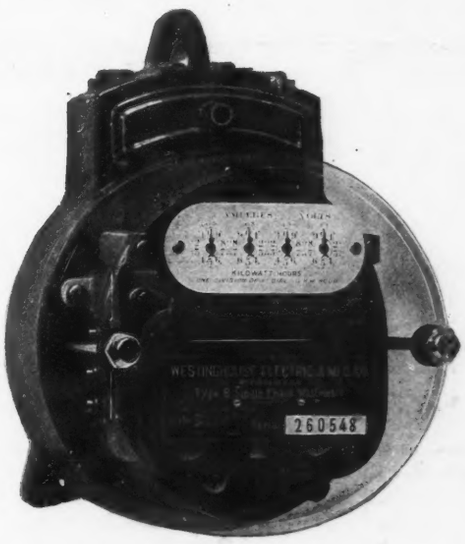

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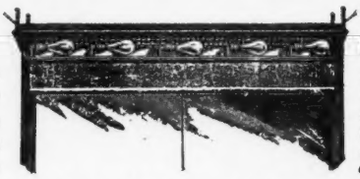

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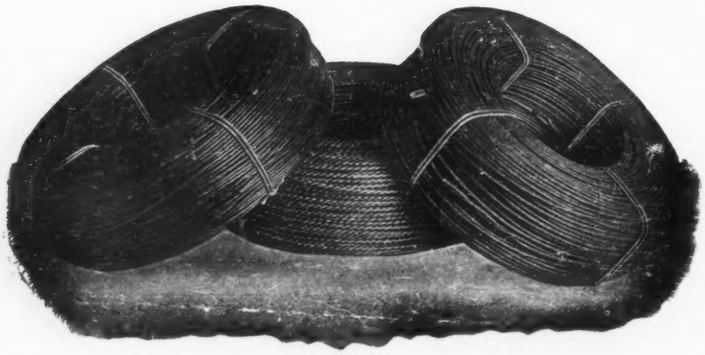

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